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MAY, 1904. VOL. XXIII. No. 5.

The Geographical Journal

INCLUDING THE PROCEEDINGS OF THE ROYAL GEOGRAPHICAL SOCIETY.

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PUBLISHED UNDER THE AUTHORITY OF THE COUNCIL
EDITED BY THE SECRETARY.

LONDON:
THE ROYAL GEOGRAPHICAL SOCIETY, 1, SAVILE ROW;
EDWARD STANFORD, 12, 13 AND 14, LONG ACRE, W.C.

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The
Geographical Journal.

No. 5. MAY, 1904. Vol. XXIII.

THE ANTARCTIC EXPEDITION.

(Work of the Second Season.)

By the President, Sir CLEMENTS R. MARKHAM, K.C.B., F.R.S.

The glad news of the arrival of the Antarctic Expedition at Lyttelton relieved many anxious hearts, and filled them with joy and peaceful anticipation of an early meeting with those so long absent. A whole year without any tidings, following upon a former interval of equal duration, was a sore trial for relations and friends. The anxiety and the strain were severe, but now they are happily ended. The last time that I addressed a meeting of our Society, I assured those present that I was convinced that Commander Scott would get the *Discovery* safely out of the ice. Now there is the certainty.

But our explorers have done their work with a completeness and thoroughness that is without any equal in polar annals. I expected that their whole energies, in the second season, would have been devoted to cutting and blasting the ship out of the ice. On the contrary, there was quite as extensive a scheme of sledge-travelling for the second as for the first season; so that the work done in the second season has quite doubled the value and importance of the general results of the expedition.

To the commander, whose rare gifts have secured these results, our first acknowledgments are due. In him have been united the confidence and resolution which goes far to win success, with that close attention to details without which the most energetic action must fail of its object, and with an influence over others acquired by the exercise of tact, judgment, and good temper. Scott is alike the skilful and bold navigator, the ideal director of a scientific staff, the organizer of measures securing the health and good spirits of his people, and the beloved commander of the chosen band of explorers, who are ready to

face hardships and dangers to secure his approval. Nor do officers and men deserve less acknowledgment. They have preserved perfect harmony and good fellowship among themselves, which is the first essential for a successful expedition; have carried out the orders and wishes of their chief with the utmost energy and zeal; have shown a true-hearted determination to further the objects of the expedition to the utmost of their power, and have worked untiringly from the highest motives. With such materials, formed in some degree by himself, our commander has been able to achieve the unequalled results of which the telegrams have given us the outline.

In the former season the insular character of the volcanoes had been discovered, and the volcanic region explored; several hundred miles of a littoral mountain range had been discovered extending to 83° S., and a point in 82° 17′ S. had been reached; and the continental land had been explored westward for a considerable distance during Mr. Armitage's memorable journey. In the second season Commander Scott resolved to lead another expedition inland to the westward, hoping, with good grounds, to make further important discoveries. He also resolved to send another extended party to examine the great barrier by means of a long journey over it; and a third to investigate the character of a wide opening in the land in 80° S.

Accordingly, in the intense cold of the early spring, Scott and Skelton laid out a depôt 60 miles from the ship, and 2000 feet above the sea, on the line of their intended route; Barne and Muloch carried one to the south, while Royds and Wilson reached Cape Crozier. The thermometer, during these trying journeys, was down to −50° and 60°; minimum, −68°.

In October the extended sledging parties started. The commander and Mr. Skelton, with four men and a supporting party of six (including Mr. Ferrar, the geologist), started on the 12th. They were delayed by the strong and icy winds blowing from the heights, but gained the summit on November 11, and crossed the magnetic meridian in 155° 30′ E. Scott proceeded westward over the icecap for eight days, with two men—Evans, who was with him in the *Majestic*, and Lashly, a fireman. Encountering great dangers through the concealed crevasses, in one of which they had a hairbreadth escape from destruction, this gallant little party reached a point 270 miles from the ship, in 78° S. and 146° 30′ E.; so that the course must have been nearly due west. The interior of South Victoria Land seemed to stretch continuously at a height of 9000 feet, a vast continental plateau. No land was visible after losing sight of the ranges which front the coast.

But it was in a glacier valley nearer the coast that the great discovery was made. Here there is a geological section laid bare. The valley was explored in detail with Mr. Ferrar, and sandstone rocks were discovered containing fossil remains of plants, apparently a Miocene

flora. This great discovery is alone worth the whole cost of the expedition. Scott has won the Patron's Medal of our Society for his journey to 82° 17′ S. in 1902, but his western journey of 1903 more than doubles his claim to it.

Meanwhile, the exploration of the ice-barrier had been entrusted to Lieut. Royds and Mr. Bernacchi, with four men and five weeks' provisions. They made their way over the ice on a south-east course until they were 160 miles from the ship. There was no sign of land, and no obstacles were encountered on the ice. Evidence was obtained showing that this vast ice-plain was afloat; and Mr. Bernacchi took a uniform series of magnetic observations.

The third extended journey, led by Lieut. Barne and Sub-Lieut. Muloch, left the ship on October 6 with four men and a supporting party of six, to examine the strait in 80° S. In the face of continuous bad weather, they reached the strait, and found that it was filled by a large glacier formed from the inland ice. Detailed information was obtained respecting the exact point of junction between the barrier ice and the land. The party was absent sixty-eight days. Several shorter journeys were made by other officers, with valuable results.

It must be remembered that all this splendid work was done without the aid of dogs.

The work of cutting the ship out was actively proceeded with, and in the last half of December persevering efforts were made to cut a passage. The Relief Expedition under the command of Captain Colbeck arrived at the edge of the ice on January 5, and great must have been the delight of the explorers to greet their old friends again. Towards the end of January the ice between the two ships began to break up rapidly, and the *Morning* reached Hut Point, close to the *Discovery*, on February 12, amidst great excitement. On the 14th two heavy charges were exploded, which placed the *Discovery* in open water. A furious gale began on the 16th; the *Discovery* dragged her anchor, and was in a very critical position for several hours. But on the 19th Commander Scott succeeded in getting seventy-five tons of coal from the relief ships before another gale came on and drove them to the north. There was a clear sea to the north of Cape Washington, where the ships parted company. The *Discovery* put into Wood bay and Robertson bay. The zeal of the explorers had in no way abated, and attempts were made to do useful work on the way home. Foiled in an attempt to round Cape North, Commander Scott skirted the pack to east and north. On March 2 the *Discovery* passed through the Balleny group. Continuing westward to the 156th meridian near Adelie Land, it was found that the coast-line shown on the chart east of that land is a mistake. No such land exists.

Want of coal obliged the *Discovery* to turn back. She arrived at Auckland island in March 15, where she was joined by the *Morning* on

the 20th, after having experienced terrific weather. Both ships were signalled off the heads at Lyttelton on the 29th.

Telegrams can only give the barest outline of the work achieved. We must wait for the return of our gallant friends to hear all the deeply interesting details, and to learn the conclusions that have been reached on the numerous geographical problems, the richness and fulness of the numerous scientific results, and the share taken by each individual. All we now know is that all have done their best. Taking all things into consideration, these two years of the work of the Antarctic Expedition represent an achievement unequalled, certainly unsurpassed, in the annals of polar exploration—Arctic or Antarctic.

With the great Antarctic Expedition the name of William Colbeck must always be associated as the leader of the two relief expeditions of 1902–3 and 1903–4; nor should his excellent officers and zealous, well-conducted crew on board our good ship *Morning* be forgotten. Our Society owes a debt to Lieut. Colbeck and his followers which can never be repaid, though the Council will endeavour to recognize their great services in the person of their commander.

We may look forward to giving all our friends an enthusiastic welcome before many months are over.

EXPLORATION IN THE SOUTHERN BORDERLAND OF ABYSSINIA.*

By Captain PHILIP MAUD, R.E.

THE main object of this expedition, undertaken and organized by Mr. Archibald Butter, was to place in the hands of Sir John Harrington, his Majesty's Agent and Consul-General in Abyssinia, information which would make it possible for him to discuss the question of the British East African and Abyssinian frontier with the Emperor Menelik, with a view to its being defined by treaty

There was no reliable information concerning the tribes in that part of Africa, nor as to the exact limits of Abyssinian occupation or influence. There had been previous expeditions in this direction from the Sudan under Major Austin, the second of which, it will be remembered, reached as far east as the Murrle district, north of Lake Rudolf. Failing, however, to meet there the Abyssinian relief caravan as expected, Major Austin turned south, down the west shore of Lake Rudolf, and, after a very hard time, reached the Uganda railway near Lake Baringo. Another expedition, with the Abyssinian southern frontier as its objective, left Zeila in 1901, but, owing to the illness of two of the survey party, the expedition was unable to continue further than the Hawash valley.

* Read at the Royal Geographical Society, January 11, 1904. Map, p. 704.

Mr. Butter had been associated with this expedition, and on his return to the coast, after making arrangements for the collection of a large number of camels at the rail head of the Jibuti railway, which was then under construction, he came home in 1902 to organize and equip an expedition which would be capable of carrying the project through.

By arrangement with the Foreign Office, I was enlisted in the expedition to take charge of the survey and report on the country and tribes which would be involved in the frontier settlement. Mr. Butter, with great public spirit, made the successful accomplishment of the survey the object of the expedition, and pursued it throughout irrespective of any questions of personal convenience or expenditure. I think it right to preface my account by stating that it is to his conduct in this respect that the satisfactory completion of the work is primarily due.

Early in September, 1902, Sir John Harrington, Mr. Butter, and I left England and duly reached Aden, where we were the guests of the Resident, Colonel Abud. Here we were met by my two survey assistants, Khan Sahib Sher Jang, of the Survey of India, and Jemadar Shahzad Mir, Bengal Lancers. Shahzad Mir had accompanied the late Captain Wellby in his two great journeys—one through Tibet, and the other from the Somali coast through Abyssinia to the Nile. Curiously enough, I had met Sher Jung in 1898, when he was plane-tabling, and I was on a reconnaissance in the grand mountain region north of Chitral and Mastuj, near the Hindu Kush watershed.

At Aden we were also met by Mohamed Hassan, the head Somali of the caravan. He reported that the camels and camel-men were awaiting our arrival at the Jibuti rail head. Mr. Butter was good enough to let me have Mohamed Hassan as head of my little survey caravan and interpreter during the most important part of the trip, and but for his skill and tact in that capacity, I might still be trying to extract information from the thick-headed natives with whom we had to deal.

After three days at Aden we crossed over to Jibuti, where we were hospitably entertained by the governor, M. Bonhoure. A day in the train landed us at rail head, at that time about 30 miles short of its present terminus, Adis Harrar. Here Butter was able to rejoice at the sight of eighty fine camels and about seventy smart Somalis specially picked by Mohamed Hassan. Of these about fifty were camel-men, and the remainder shikaris, tent-boys, cooks, and survey assistants. Most of the camels were from the Danakil country. They are distinguished by their dark colour, and are noted as hill camels. They require more water than the light-coloured Berbera camel. The latter, though he can, with average feed, march for seven days or so without water, yet makes very heavy weather on a steep incline.

Our march to the Hawash river through the Danakil country was uneventful. This tribe have a bad reputation, but except for the

inevitable altercations at wells and water-holes, and stealing a camel, which they were made to return, we had no trouble with them. Specimens of kudu, aoul, water-buck, oryx, bush buck, gerenuk, and ostrich were bagged, and Butter, after a long track, shot a fine lion which had been committing depredations near one of our camps.

Spare time was utilized in drilling the boys, twenty-five of whom were armed with Martini, and twenty-five with Lee-Metford carbines. They were taught to handle, load, and fire their rifles, and to take alarm posts rapidly. A few rounds of ammunition were spared for practice shooting. Very few of the boys had ever handled a rifle before, and they have little natural aptitude for marksmanship, though letting off their rifles gave them the keenest pleasure. To attempt to make even moderate shots of them was impossible. They, however, quite enjoyed their drills, and, judging by these boys, I can understand the opinion which I believe our officers in Somaliland have arrived at—that Somalis take kindly to drill up to a certain point and make excellent scouts, but cannot stand much discipline, and could never make smart, well-trained, and reliable troops like those in our native regiments of Northern India.

We marched along the foot of the range of hills which separates the province of Harrar from the Danakil country, and struck the Hawash river at Billen, which is noted for its hot springs.

After one march up the right bank of the river, Harrington, Butter, and I separated from Butter's main caravan, which was sent up the Hawash valley to await our arrival in the neighbourhood of the great extinct volcano Gara Zukwala, while we with a small caravan of mules followed the main route to Adis Ababa. This separation was necessary, as Adis Ababa stands 8000 feet above the sea, an altitude unsuitable for camels. On nearing the Abyssinian capital, we were met by Mr. L. J. Baird, who had been acting for Sir John Harrington during his absence at home, and Captain A. A. Duff. They had managed to survive the dreary rain season, which was just over.

For three weeks we were the guests of Sir John Harrington at the British residency. During that time he arranged matters with the Emperor Menelik, and when all was settled, we rode over the 30 miles to Adis Alam, Menelik's rain station, to be presented to the "King of Kings of Ethiopia." The new carriage road from Adis Alam to Adis Ababa, engineered by Italians, had been started from the Adis Alam end, and some very solid work was being put into it. After lunch at the Italian Legation, where we were the guests of the Italian minister, Major Frederick Ciccodicola, we rode to Menelik's residence, and were presented by Sir John Harrington.

The "tukle" is the universal form of architecture in Abyssinia. Churches and houses only differ in size. It is circular, with a conical roof, generally supported by a centre pole. The walls consist of wooden

uprights covered with wattle and daub. A group of these in the distance gives the effect of tents. The "Gibbe," Menelik's residence at Adis Ababa, is much more elaborate, the Indian artificers whom Menelik employs having added a bungalow in the European style to the royal "tukles."

Menelik's rain-season quarters at Adis Alam consist of a collection of large and well-built "tukles," situated on a small hill, the whole surrounded by a high wooden stockade. His Majesty received us seated cross-legged on a brass bedstead, which was covered with rugs. He was dressed in white, his head-dress a white handkerchief fitting closely round his brow and knotted behind. In turn we shook hands with the monarch, and then sat on chairs in a row in front of him. His attendants grouped themselves, standing on either side. They were dressed in their national costume—white cotton pyjamas, and the "shama" or white shoulder-wrap, which is intersected by a broad red band. There was a marked absence of the pomp and circumstance of the Abyssinian court, which is so well described by Major Swayne in his account of the Rodd Mission to Menelik.

The emperor is now an old man; but, though I only saw him seated, he appeared full of vigour, and took great interest in the conversation (conducted by an interpreter), the subject of which was supplied when Butter presented him with a pointer dog. Menelik is a great lover of dogs, and was very pleased with the present. After a short audience we took our leave, with Menelik's best wishes for the success of the expedition.

The next day we returned to Adis Ababa, and on November 6, 1902, we took leave of our kind host Harrington, and set off south towards Gara Zukwala, which towered its 5000 feet 30 miles distant over the grassy undulating plain. The expedition had been now augmented by Mr. J. L. Baird and Mr. Wakeman, the residency surgeon. Count Colli di Felizano, secretary to the Italian legation, also accompanied the expedition with the intention of going as far as Lake Rudolf, and then returning direct to Adis Ababa. It had been arranged that Captain Duff, who remained at Adis Ababa, should take a relief caravan with provisions to meet us at the north end of Lake Rudolf at the beginning of April, 1903. Menelik was represented on the expedition by two Kaniasmuches, one of the Boran country and one of Sidamo, and by an Abyssinian gentleman, Atta Mama. The two former were simply instructed to follow us wherever we went, and to render us every assistance they could. Atta Mama, who has spent several years in France and is an educated man, was instructed to write an account of the expedition.

From Adis Ababa to Gara Zukwala there stretches an open undulating plain with a steady fall to the south. It is intersected by deep ravines carrying tributary water to the Hawash river. The plain is dotted over with villages and cultivation, but the greater part, though covered

with excellent grass, is ungrazed and left waste. East of Zukwala we found Mahomed Hassan with the main caravan, all impatient to be on the march. Baird and I made the ascent of Gara Zukwala, while the remainder, after halting a day, continued to march south. Gara Zukwala is an extinct volcano, and in shape is a wonderfully symmetrical cone. The apex is blunted and hollowed into a large crater, at the bottom of which is a lake supposed to be unfathomable. The summit is inhabited by Abyssinian priests, and there are several churches nestling among its trees and rocks. The place is regarded as sacred, and pilgrimages are made to it from far round. From every point on the edge of the crater a magnificent panorama lay before us. The best part of the night was spent taking astronomical observations on a prominent point on the edge of the crater in a gale of wind, which made work very difficult.

On our way down the mountain next day we were invited to a feast by the Fitorari of the district, who was up there superintending the building of a church. Entering his "tukle," we were conducted to a settee covered with skins. Serving-women brought us water to wash our hands, and then flat baskets, on which were high piles of thin flat breads, like the "chuppaties" of the East. The women cooks brought in large dishes of stewed meat, and, after tasting each dish to show that it was not poisoned, they picked out tit-bits and presented them to us on "chuppaties." The whole meal was served without plates, knives, or forks. It is surprising how easily these necessities of our civilization can be dispensed with. Serving-men meantime plied us with "tej," the national drink of Abyssinia, which is made from honey. Old "tej" is very heady, but not unpleasant in taste. Abyssinians of importance never travel without their "tej" women. These ladies make the "tej" in camp, and carry it on the march. The Fitorari—a courteous and dignified Abyssinian—did not join us at this meal, but remained seated on his couch, giving orders for our entertainment. Our Somalis were given a similar meal in another division of the "tukle," and I noticed that though they must have guessed that their food had not been cooked by one of the faithful of Islam, yet they asked no questions. Hunger is a great leveller.

It was late before we reached the foot of the mountain, and, being unable in the dark to find the tracks of the caravan, which had marched on, we had some difficulty in making camp, but eventually our signal shots were answered by a rocket from camp, and then our troubles were over. On several occasions these signal rockets, which are made up in a large cartridge and fired from a pistol, were found invaluable for finding camp after dark. From Gara Zukwala to the south end of Lake Zwai the country we passed through was an immense park of mimosa cedars and other smaller thorn trees, with thick patches of high grass and bush in places. The Hawash river, which is only fordable

in places, is fringed with fine tropical jungle. The few inhabitants we came across were Galla cattle-herds who do not cultivate. Game was scarce except at the foot of Gara Alutu, where there were large herds of Swayne's hartebeest and Grant's gazelle.

Baird and I ascended Gara Alutu, and from it obtained a fine view of the lake district. Lake Zwai, the level of which is about 5500 feet above the sea, is the most north-easterly of the lakes in the great chain which terminates with Lake Rudolf (level, 1300 feet), or perhaps I should say Lake Sugota. The three northern lakes in this chain are connected. Lake Abaya is reported to have an overflow in the rains into the Sagan river, so that its basin is at times connected with that

FORDING THE SUK SUKI RIVER.

of Lake Stefanie, which has no outlet. Lake Rudolf lies in a separate basin, as most probably does also Lake Sugota. Thus the drainage of the large area of country which finds its way into this chain of lakes is self-contained. To the south-east it is cut off from the basins of the Daua, Ganale and Webbe Shebeli rivers by the main Sidamo range which forms part of the unbroken watershed extending from the hills east of Lake Stefanie to the Harrar range.

South of Lake Langano (the water of which, like that of Lake Zwai, is slightly brackish, but drinkable) the flat country is studded with a *Euphorbia*, which in this district grows to a great size. South of Lake Shala there were thick patches of forest, between which we came on Abyssinian settlements and cultivation.

A gradual ascent from the lakes brought us to a low watershed, which separates the basin of the Zwai group of lakes from that of Lake Awasa. To the west Gara Abaro, covered with virgin forest, forms a very prominent landmark. It was with great difficulty, and in torrents of rain, that the survey party forced its way up this hill through thick matted undergrowth. Near the summit, which we only found with difficulty, we "jumped" some buffalo, but did not get a glimpse of them. There were also fresh tracks of greater kudu, but no indication that man had ever disturbed this retreat before. After making a few lanes through the trees on the summit, I was able to see from this commanding point that the country to the east was mountainous, and covered with dense forest as far as the eye could reach. As only very small streams flow into the Awasa basin from this side, this mountainous region must drain into the Ganale and Webbi Shebele rivers. I spent the most miserable night of the whole trip on this hill, making observations for latitude during partially clear intervals between torrents of rain. The saucer-shaped basin of Lake Awasa has no outlet; its height is about 5600 feet. A broad canal, which connects the two portions of the lake, is bridged by a floating causeway of reeds. We passed long strings of Galla women threading their way in file through the high grass, carrying grain to market.

A short steep ascent from the Awasa basin brought us on to the fertile plateau of Sidamo, the level of which is some 6500 feet above the sea. The monotonous bush of Africa had been left behind, and we entered into a lovely country where only man, in the shape of miserable specimens of the Galla race, was vile. Our camps, pitched in grass glades lying snugly between patches of thick forest, were besieged by the maimed, halt, and blind, who hoped that the white man would heal them. Our camels were regarded by the natives with great wonder; few of them had ever seen a camel before. It was only about 1895 that the Abyssinians conquered and annexed this country. It is now subdivided into districts under Abyssinian governors, who live with their feudal retainers in stockaded villages.

The country is sparsely inhabited, though it is very fertile and well watered by many perennial streams flowing west into Lake Abaya. The climate is delightful, but there is probably a large, though well-distributed rainfall.

In order to reach our objective point on the Ganale river, it was necessary for us now to be turning south-west, and inquiry decided us that the best place to cross the main Sidamo range, which rose before us in that direction, was near Gurbicho. The ascent looked most unpromising, if not impossible, for camels. Abyssinians are very fond of high ground for their settlements. Two prominent hills, Sisha and Gurbicho, were crowned by large stockaded villages. Baird and I broke off from the main caravan south of the Giddabo river, and, after visiting

Sisha, we struck across some fine hill country, in places covered with magnificent forest, to Gurbicho. The normal light green of the foliage was relieved by the sombre hue of giant cotton trees. Torrents, fringed with huge ferns and other tropical vegetation, frequently intersected our path. Rounding a shoulder of Gara Gurbicho, which is 8300 feet above the sea, we came on the main track to the stockaded village, up which the camels of the caravan were toiling painfully. The altitude of the Sidamo plateau had already been too much for them, and this

CROSSING RAVINE IN SIDAMO.

steep 2000-feet ascent practically finished them off. Camp was pitched a mile beyond and overlooking Gurbicho. A zareba was at once made, and piles of firewood collected inside, to keep the camels warm at night, but in spite of these precautions several camels died.

Mr. Butter decided that the main caravan, with the stronger camels very lightly laden, and the remainder without loads, should hurry on over the watershed and down to a lower altitude and green thorn feed, which are the camel's best medicine. The Sidamo Kaniasmuch, who was with us, obligingly arranged to collect Galla porters to carry the

remaining loads. Meanwhile I was to follow on with the survey party and a small caravan of donkeys and mules as fast as the survey work would allow. While making these arrangements we received a visit from the local Fitorari, whose headquarters were at the foot of Gara Gurbicho. He was accompanied by a retinue of over 200 men—Abyssinians and Gallas—all armed with rifles, but he apologized for the smallness of his following.

Leaving Gurbicho on December 6, an ascent of a few hundred feet brought us to the main watershed, over which we passed at a height of about 9000 feet. The high ground on both sides of the watershed was well wooded with bamboo jungle. To the south-east the descent was gradual through the Jumm Jumm district of Sidamo. Our route lay along an undulating watershed, from which a succession of nullahs branched off to join two large valleys which ran parallel to us on either side. The valley to the east proved afterwards to be one of the main tributaries of the Ganale river, and that to the west the largest head-water of the Daua river. The hilltops were covered with dense forests, while the broad swampy valleys, which all contained perennial water, were open grass. There were very few inhabitants and little cultivation. I found the stockaded village Irba Moda on the top of a hill which I visited for surveying, and was told that this was the most southerly Abyssinian settlement in Sidamo. The natives were another section of the ubiquitous Galla race. These highlands are abruptly terminated by a well-marked escarpment, which runs from the Ganale valley in a southerly direction. The Daua river, after forcing its way through this escarp in a deep gorge, bends round south and follows its foot for some 40 miles. Here this escarp is approached by another escarp, which forms the western boundary of the north-western Liban, and the Daua river enters the deep valley thus formed.

The top and slopes of the Sidamo escarpment, as I call the first one, are covered with dense forest. The original narrow path through the forest had been improved into a route for our benefit by our Abyssinian colleagues, who had sent Galla clearing parties on ahead. My guide explained to me as we entered the forest that this point was considered the dividing-line between the high cold country and the hot low country, and it is certainly the natural eastern boundary of the Sidamo highlands. In the dimly lit forest we were frequently entertained by troops of the handsome white-tailed Colobus monkey. These were the first undomesticated animals we had seen in Sidamo.

Emerging from the forest at the bottom of the steep descent of the escarpment, we came on a low watershed, from either side of which a broad valley runs down to the Ganale and Daua rivers. The latter opens out into the undulating forest-clad plain of Adola, which is enclosed by the two escarpments to which I have just referred. Here were fresh tracks of elephants. I afterwards learnt that Butter, while

hunting in the thick forest, had a narrow escape. An infuriated cow elephant charged him in an alley walled in by impenetrable undergrowth. His shots failed to turn her, and she got right over him as he attempted to wriggle out of sight. While she searched around with her trunk, Butter gave her both barrels of his ·577 rifle from underneath, which caused her to depart, luckily without treading on him. Baird was more fortunate, and secured a good bull with tusks weighing about 50 lbs. each.

Continuing south-east, an ascent of a few hundred feet brought us on to some hilly uplands. The country had changed its character, but not its name, as we were still in Jumm Jumm. The forest became

GALLAS IN SIDAMO.

smaller and rarer as we marched south-east, and gradually gave way to thorn bush. For weeks past we had never given a thought to water, as it flowed in every valley; but very soon we passed out of the region of running water, and except the main Ganale and Daua rivers, we found no perennial streams again till south of Lake Rudolf. The water question had henceforth to be always uppermost in our thoughts.

On December 21 I found the main camp halted at Darar, in Liban, just over the Jumm Jumm frontier. The whole of the eastern part of Jumm Jumm from the Sidamo escarpment to Darar was uninhabited, but here we made the acquaintance of some of the Boran and Gubbra people, who had brought camels for sale. We were destined to improve

our knowledge of them later on. The Darar district contains no permanent villages, but is a religious centre, to which Borans make pilgrimages. We all spent Christmas together at Darar, and then Baird and I set off with a small caravan of mules and donkeys north-east to hunt for the bend on the Ganale river, which was our "jumping-off" point. Meanwhile Butter, taking the main caravan, struck south to find the Daua river, and to survey and investigate in its neighbourhood till our arrival.

After two days' march over hilly country, we sighted the Ganala river to the east, and commenced a long descent to its banks. The whole district was uninhabited. The river flows in a broad, deep valley, which occasionally narrows to a gorge. There were many rapids, and occasional broad expanses of deep, slow-running water where hippopotami were numerous. Its banks are fringed with tropical vegetation, but a few yards away from the river one is confronted by thick thorn bush, through which it was often difficult to find a way for the caravan. Elephant and rhino tracks were ubiquitous. These monsters are certainly the best road-makers in Africa; but for their engineering efforts in this line our progress would have been much slower. Baird shot a good rhino, but, except partridges and dik dik near the river-banks, we had no other sport. Among the hills some of the rhino paths were extraordinarily well graded. Unfortunately, the rhino has a hide some three-quarters of an inch thick, and so does not see the necessity of clearing the thorn bush from over his road. An elephant is more considerate—he makes a clean sweep of everything in his path.

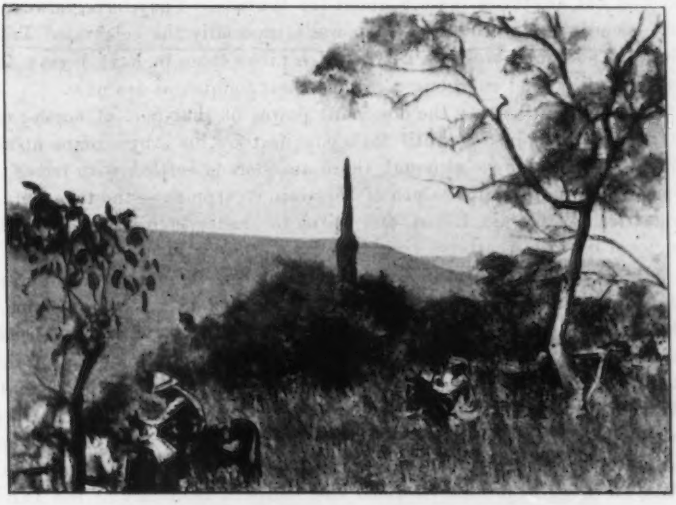
It was not until I had surveyed about 50 miles of the river that I was able to identify the bend of which we were in quest, as Bòttego, the only traveller who had previously been up the river, had surveyed this part of his exploration roughly, and his latitude was about 20′ too far north. His topography of the river is, however, very accurate considering the rough methods he employed.

The country called Liban varies greatly in character. To the north are the uninhabited highlands. From the sharp bend of the Ganale river, which was our first objective, a well-marked ridge covered with "ted" fir trees extends south to the Daua river. West of this ridge, Kurre Liban, the country is undulating, with a steady fall to the Daua valley. To the east of Kurre Liban extends Dida Liban, a vast waterless plain, in places open and dead flat for miles, in others undulating with patches of thorn bush. Here we found ostriches, hartebeest, oryx, and Grant's gazelle in large numbers.

The only inhabitants of Liban cluster round the perennial wells which surround the northern parts of Kurre Liban. In the rains they trek within a radius of about two marches distant from their headquarters. These people are the Gona section of the Boran tribe. Their chief, Aba

Guyo Ana (Aba means "father of"), was too old and decrepit to accompany us, so sent his cousin Gullgullo, who became my "intelligence officer" for the next few months.

On January 22, 1903, the expedition reunited near the junction of the Awata and Aflata rivers, the combined waters of which constitute the Daua river. After fitting out two flying caravans with provisions for two months, Mr. Butter sent the main caravan six marches south-west to Ronso, where good grazing was reported. From information received, it seemed certain that this place would lie close to our route when we later on would travel west to Lake Rudolf.



COUNTRY NEAR GANALE RIVER.

Owing to the large area of country which it was necessary to investigate, these two caravans, after making a wide loop eastwards and meeting again, were subdivided, and for the next three months Butter, Baird, and I were generally exploring separately in different directions, thus making the network of tracks in the Boran and Gurre country which are shown on the map. Some two months later, when in Western Dirri, we refitted from the main caravan, which was again sent on ahead. The whole expedition was not reunited till May 24, on the shore of Lake Rudolf.

We constantly communicated with each other by mounted messengers. The Somalis selected for this important work could speak a little Galla. By the aid of occasional inquiries and their cleverness in tracking, they never went far astray. They travelled, walking and riding, over 40

miles a day, and carried messages up to 150 miles. In this manner we were able to collect and exchange information over a very large area, which an expedition fewer in numbers or less well equipped could never have done.

The Borans say that long ago they all lived in Liban. The headquarters of their kings and of their religion (the worship of Wak) was near Darar, still a great religious centre. Many years ago the Borans made an invasion to the south-west across the Daua river into Dirri, which was then occupied by the Wurrda, who were a "Suffara" tribe, that is, of Somali origin. The Wurrda were driven out to the south-east, and the invaders settled in the conquered country. I was unable to find out anything further about the Wurrda. They have, however, left records in the shape of deep wells, especially the celebrated Tulu Sullunn perennial wells of Dirri, which prove them to have been a far more civilized and energetic race than their conquerors are now.

The Borans became the dominant power of that part of north-east Africa, and remained so until their conquest by the Abyssinians about six years ago. Now—although there are Borans settled with tribes of Somali origin in Golbo, south of the Goro escarpment—the true Boran countries are Tertale, Liban, and Dirri, the latter being the highlands enclosed between the Daua river and the Goro escarpment.

Dr. Donaldson Smith, in 1899, descended this same escarpment west of Meg, where it almost warrants his description of it as "a precipice." But he was under the impression that it ran, from where he struck it, south to Mount Marsabit, and formed the western boundary of the Boran highlands, which he thought extended as far south as that. We imagined this to be the case until Mr. Butter, while at a separate camp at Das, first heard from the Borans that there was an escarpment (as he understood them to mean) some four or five marches to the south. This, he thought, probably formed the southern boundary of the Dirri highlands. Hitherto we had had no notion how far south the Boran country extended. I was at the time about 150 miles to the east, but Mr. Butter at once sent messengers informing me of this report, and desiring me to extend the survey much further south than was originally intended. He then proceeded south himself to verify the report. I duly received his message five days later, as I was returning west from the Gurre country, and therefore turned south to look for the eastern prolongation of the escarpment. About the same time I received a message from Mr. Baird, who had in Western Dirri heard a similar report, and suggested that the rumoured escarpment might be the same as that mentioned by Dr. Donaldson Smith. The very day I struck the Goro escarpment at Goro at Kuddaduma, I received a second message from Butter, saying that he had been to Jamok, which was on the edge of the escarpment, and was moving south-east to meet me. Our subsequent investigations brought to light the full extent of this great

natural feature, and showed that both Butter's and Baird's assumptions were correct, as the highlands of Dirri are terminated by this escarpment, which, a little south of Gara Meg, takes a great sweep round to the south-east. It continues in that direction as far as Kuddaduma, east of which it dies away, and the upper and lower levels merge in a long slope.

The lowest part of Dirri is the plain of Jillbabo, which is little over 3000 feet above the sea. North-west of this plain are the Arero highlands, over 5000 feet. On a pleasant fertile plateau in this district is

GEDDU WITH SWORD PRESENTED TO HIM BY MR. BUTTER.

a stockaded village, the only Abyssinian post south of Sidamo. From this centre the Abyssinians control the whole of Dirri, Tertale, and the inhabited part of Liban. Round Gara Meg the general level of the country is over 5000 feet. This is the culminating point of the Dirri highlands. The mountain masses of Gamudd and Gubala rise to 3000 feet higher, forming a gigantic natural balustrade to the escarpment. At Funan Guba ("the nose of the highlands") the escarpment comes to an end abruptly, and north of this long easy slopes connect the

highlands of Dirri with Golbo. The level of Golbo rises from 2000 feet under the extreme eastern slopes of the escarpment to 3000 feet west of Gara Gamudd, thus making the height of this great natural retaining wall from 1500 to 2000 feet.

Overlooking Golbo from one of the many hills perched on the edge of the escarp, with a command of often several thousand feet, this vast plain looked like the ocean as seen from an eminence. Its undulations were not apparent, and with half-shut eyes it required but little imagination to take the different colours of the plain, as it changed from bush to open grass, for the effect of sunlight and cloud shadow on water, and the isolated hills, rising abruptly out of the plain, for islands. The distant horizon merging with the sky completed the illusion.

The whole of Dirri is, with the exception of some large open plains in the south-west, covered with thorn and other bush. Its undulations are studded with isolated hills and groups of hills. In the Meg district there are many volcanic craters long since extinct. From G. Meg, the summit of which is itself a large broken crater, I overlooked two or three large craters lying isolated in the middle of the open plain. From the shores of the lake in one of them (Sod) salt is obtained, which is sent all over the Boran country.

The Boran people are divided into two great sections—the Subbu and the Gona. Each of these sections is again divided into about eighteen subtribes. The chief of Gona is Aba Guyo Ana, whose subtribe is Wadittu. The royal subtribe of the Subbu is Kurrayu, which is the most exclusive and powerful subtribe of the whole nation. Abo Fullato was king of the Subbu until recently, when he was superseded by his stepson Geddu. Geddu is the son of Abo Fullato's predecessor, but was born after his father's death and his mother's marriage with Abo Fullato. The latter was merely regent during Geddu's minority, but he attempted to retain his power by representing that Geddu was his own son. Geddu, however, disclaimed any closer relationship than stepson, and succeeded in ousting Abo Fullato. Quite an interesting bit of court scandal!

Roughly speaking, the Gona inhabit Liban, and the Subbu, Dirri and Tertale. However, in any Boran village, except those of the Kurrayu, one finds representatives of several subtribes of both sections, who intermarry freely. In addition to the above there are the Wata, the low hunter caste of the Boran.

The difficulty of obtaining information from the natives was very great. I remember once telling a Somali, Fara, who acted as my interpreter in Mohamed Hassan's absence, to ask a Boran some simple question about the route. After ten minutes' conversation, he appeared to be coming to an understanding with the Boran, so I asked what the man had said. My interpreter implored me not to interrupt, as he was just getting to the point. Nearly another ten minutes elapsed before my

patience broke down, and I demanded what he had elicited. "He says that he is a very poor man and has only two cows," was his reply. I won't say what mine was.

The Borans live mainly upon cow's milk, which they drink curdled. On special occasions they eat cooked meat. They are essentially cattle-herds, but keep also sheep, goats, and a few loading camels. In the western part of Dirri they have a good breed of small donkeys, and also ponies from 13 to 14 hands, strong, but as lazy as their masters. The Boran village consists of a thorn zareba containing inner cattle-enclosures and semi-spherical grass huts for from ten to eighty families. Those in the neighbourhood of the perennial wells are permanent. During the rains the people wander round their dry-weather station to a distance of two or three marches, and make villages where they find water and grazing. As they have to water their cattle every other day, they can never go far from water. The thickest population is found near the celebrated Talu Sullunn wells, a legacy of the Wurrda tribe whom the Borans drove out of Dirri. Besides watering and tending their cattle, the Borans do no work. They are intensely lazy. Physically they are a fine race, but whatever courage they may once have possessed has completely evaporated. They carry long spears with huge blades, which look grotesque in the hands of such a craven race. They wear loose knickers of American cotton cloth, and a wrap of the same material over their shoulders. These garments are treated with "ghi" till they look like black waterproof. This American cloth is very durable, and is the only cloth for which there is any demand. It is the ordinary medium of exchange among the tribes from Dirri to the coast. The Boran either shaves his head, or keeps his hair short or long in ghi-covered ringlets, but he always wears a small pigtail. He ornaments himself with a necklace of small beads or plaited giraffe tail-hairs, also with many heavy bracelets of metal and ivory, which often encase his arm up to the elbow. Each of these is supposed to represent some dangerous animal, including man, which he has slain. Bands and tabs of giraffe-skin complete his costume.

The Borans are polygamists, if they can afford the luxury. Their women have to content themselves with leather garments made of bullock-hides scraped thin, cloth being considered much too valuable for them. They are weighed down with many bead necklaces. Their religion consists in a belief in a spirit, "Wak." The vagueness of their conception of "Wak" is shown by the fact that the same word is used in the Boran tongue for the sky. They might, in fact, be called sky-worshippers. They do not believe in any future state of existence, but try to avert present calamity by propitiating Wak. This is done by sacrificing their children and their cattle. The sacrifice of the former is the essence of their extraordinary tribal custom of "Raba." A Boran

of any standing, when he marries, becomes a "Raba," and for a certain period after marriage, probably four to eight years, he is obliged to leave any children that are born to him to die in the bush. No Boran cares to contemplate the fearful calamities with which Wak would visit him if he failed in this duty. I was not able to discover the rule fixing the termination of this period; accounts were very contradictory. The many Borans whom I questioned on the subject were unable to conceive what I wanted to know for. Some of them tried their best, but were unable to give any consecutive explanation, and indulged in the most absurd contradictions. After twenty minutes' conversation, a Boran gets bored; his attention wanders, and if forced to give an answer, he will say the first thing which comes into his thick head; that is never the truth. After the "Raba" period, the Boran is circumcised and becomes a "Gudda." This word happens to be the Hindustan for "ass," but if there were any connection, the Boran would certainly be entitled to the rank earlier in life. Wak has no claim on Gudda's children, but neither has the Gudda himself. He has to send them off at a very early age, with a present of cattle and sheep, to be brought up by the Wata, who are the low hunter caste of the Boran. They remain with these people till they are grown up, and then return to the bosom of their families.

Every seven years or so one of the kings holds what is known as his "Jila" at Darar, in Liban. This lasts for some months, during which period his subjects make a pilgrimage to him. They take him presents, rub him over with ghi, and he blesses them. Great meaning is attached to the manner in which a Boran wears his hair—short or long, with ghi or without ghi. The old men are called "Yub." They take no part in public affairs, and carry a staff instead of a spear. For certain periods, during which they must remain at home, they wear an extraordinary head-dress—the "Kullũcha"—consisting of a metal band round the head, from the front of which projects a long polished wooden spike, like the horn of a unicorn. While wearing this, the Yub puts ghi on his head, and is forbidden to wash it. This custom would cause a Boran no inconvenience. All these customs are bound up with their religion, and they seem to be very numerous.

I will now turn to the tribes further east. Many years after the Boran occupation of Dirri, there was an invasion from the east into the most eastern Boran country by Mussulman of Somali origin. It is quite impossible to assign any dates to these events. The Mussulman drove the Boran back, and occupied the country probably up to about lat. 39° 45′ south of the Dana river. After a certain period they began to withdraw again to the east, but not *en masse*. Those who had penetrated further west, weakened by the exodus of many of their number, came under the influence of the Boran, and were reduced to the position of a subject tribe. These are the Gubbra Migo, who, like all Somali tribes,

are camel-owners ("Gubbra" is the Boran for "slave"). Their relations to the Boran become peculiar. They were divided up among the different Boran subtribes, and took the name of the subtribe to which they were attached. They forgot their language, and lost all national pride, and were only too glad to call themselves "Boran" for the sake of protection. Gubbra Migo often live in the same settlements with the Boran, but have their separate zareba. They do not intermarry with the Boran, nor have they adopted the latter's customs or religion, though they retain very little of their own.

The Gurre are also descendants of the Mussulman who migrated westwards, but, unlike their cousins who have become Gubbra Migo,

BORANS (MOSTLY YUBS).

they remained in the country they had occupied in sufficient numbers to maintain their independence. Their country now is bounded on the north by the Daua river, and extends from the Ganale river to Mullka Murri, Chillako, and G. Dandu, and south as far as El Wak.

The language of the Gurre east of Muddo is Somali. Round Muddo they speak both Somali and Boran, while those further west speak Boran only. It is a gradual transition from Somali in the east to Boran in the west. In a similar way, their religion—Islam—which is by report strictly observed in the east, is more and more neglected as one goes west, till among the most western Gurre I found that the people leave all the praying to their chiefs. They merely call

themselves followers of Islam, eat "halal," keep their women's heads covered, and give the Mussulman salutation "salaam" instead of the Boran "gari." The Gurre greatly admired the religious performances of our boys at evening "prayer," which was held regularly in camp. Their physiognomy shows their Somali origin, and they are more intelligent than the Boran. They wear American cotton cloth garments, a few light metal bracelets, small bead necklaces, and leather charms. They usually carry a light spear. Their women wear leather garments, dark cloth head-covering, and are loaded with bead necklaces. A great many of the Gurre trade in American cloth, which they obtain from Lugh, Bardera, and a little from Kismayu.

The great chief of the Gurre is a fine old man named Ali Abdi, who was with us in Guba Gullgullo. He stated that the Gurre originated from the Huwiya Somalis, and came long ago from Merka on the coast. Ali Abdi is a great mullah, and was glad to join our boys at prayer. He was much perplexed at a letter which he had recently received from the Somali mad mullah, informing him that the latter might have to retreat south-east, in which case he would come and look Ali Abdi up, and call on him to join him in the "jehad." The mad mullah has written several letters like this, and they have perplexed perhaps wiser heads than Ali Abdi's.

The Gurre are mainly camel-owners, but those in the neighbourhood of wells keep also cattle, sheep, and goats. If they can find green feed for camels, they are independent of water. Under these conditions their camels can do without water for weeks, and they themselves require nothing but camel's milk to live upon. These conditions prevail further east all over the interior of Somaliland. The normal diet of the Somali is camel's milk, but his digestive powers are remarkable. Our own boys, for the first few months of the expedition, were given the official rations of one pound of rice, quarter of a pound of dates, and two ounces of "ghi," but, as must always be the case on a long expedition, they were later on fed on meat alone. Eight pounds of beef per man per day, cooked hard and dry, without any condiment except salt, was what our boys simply thrived on. The bullocks which supplied this beef were purchased in the Boran country, and were driven along behind the caravan. So the Somalis' commissariat furnished its own transport.

The eastern Gurre country is, except for the Daua river, practically waterless. The longest trip I did carrying water was the 65 miles from Chillako to Mullka Murri. This was over a dead, flat, thorn-covered plain about 3200 feet above the sea. The soil was brick-red, and every one's garments were soon coloured. Many of the boys plastered their heads with red mud. The most persevering succeeded in reducing their naturally black hair to a tawny colour, of which they were immensely proud.

Country of this description occupies the space between the plain of

Jillbabo and the Daua river, and extends east certainly as far as Muddo, and south to Banissa. South of this the country gradually falls to meet the lower level of Golbo. The Daua river near Mullka Murri runs in a broad valley 2000 feet below the plain level. This valley is cut clean out of the plain, and until one is close upon it there are no indications of its existence. The sides of the valley and its subsidiary nullahs are covered with thorn bush, and the banks of the river fringed with dum palms and other tropical vegetation. There was a magnificent grove of these palms at Mullka Murri.

As far as sport was concerned, the country was very disappointing. Butter shot a lion, the only one, I believe, in Dirri! A good number of ostriches were bagged in western Dirri, and in the uninhabited parts there were always a few of Grant's gazelle and oryx. The hills above the Goro escarpment were good greater kudu ground. Elephants used to abound in southern Dirri, but they have been shot out, or have retreated below the escarpment.

Before leaving Dirri the rainy season came upon us, and delayed the survey work considerably. The atmosphere during the fine intervals was wonderfully clear, enabling me to intersect hills over 100 miles distant.

The arm of the Golbo, which stretches north between Dirri and Lake Stefanie, is undulating and covered with the ubiquitous bush. Large stretches strewn with volcanic boulders made the going very bad. The isolated hills with which the plain is studded are mostly of volcanic origin. At Muggado, Gorai, and Dillo there were remarkable craters all on much the same pattern. Approaching Gara Dillo, it appeared merely a low rounded hill. A climb of 200 feet, and one was on the edge of an immense circular crater, over a mile in diameter, with perpendicular sides, at the bottom of which, far below the level of the outer plain, lay a lake, from the shore of which salt is dug. The plain is intersected by a few nullahs running south from the Tertale highlands. The most western of them, Lugga Bullull, was carrying rain-water when we crossed it on April 30, 1903. It flows south, probably into a sheet of water which I saw from Mount Kulal. From this rain-water lake a broad, well-marked nullah runs southwards.

This salient of Golbo runs up to a low watershed connecting Tertale and the Dirri highlands. This I believe to be the only marked depression in the great watershed which runs from Harrar to Lake Stefanie. Mr. Baird, accompanied by Count Colli, visited the Tertale plateau early in April, 1903, and there first heard rumours of Captain Duff. He got into communication with him, and soon after their caravans met. Captain Duff had come down from Adis Ababa, as arranged, travelling on the low ground north of the chain of lakes, with a caravan of donkeys laden with flour. At this point Count Colli left the expedition and returned direct to Adis Ababa.

The western part of the Golbo, between Dirri and Lake Stefanie, is uninhabited, but east of Gorai there are Borans called Hofta (to distinguish them from their highland brethren) and Gubbra Algan, who are a small tribe subject to the Borans. They are a different type, but copy the Boran's dress and ornaments, and their old men wear the pigtail. They do not inter-marry with the Boran, nor share their religion with its peculiar customs. They believe in a spirit, Rubbi (doubtless the same as the Arabic "Rubb," meaning God), but only call on him when they want rain. They are camel-owners and nomads, but have lately closed eastward to avoid being raided by a naked tribe called Summader, who come from the direction of the south end of Lake Rudolf.

After visiting Gara Hichenni, which was one of my most commanding survey stations, I skirted round the south shore of Lake Stefanie, where there were large herds of oryx, zebra, and Grant gazelle. The oryx were very unsophisticated. One herd, full of curiosity, charged up to within 150 yards of me, and then stood in a long line staring their fill at the extraordinary apparition. Both sides remained motionless, but I quietly got my glasses on to them to see if there were any with particularly good horns. The spell was broken by my shikari pointing excitedly to indicate one he thought bigger than the rest. The herd, as if by signal, made off at a gallop in a cloud of dust.

Here, as is always the case where there are large herds of game, were numerous lion tracks. Threading my way through the thorn bush, I got a shot at a fine leopard, and was lucky enough to lay him low. A little further on I sighted Mr. Butter's camp, from which I had been separated for about ten days, and was soon receiving congratulations on my leopard from Butter, Baird, and Duff, who modestly pointed to the result of their morning's sport—four fine lion-skins, then being pegged out to dry. They had also secured two pretty little cubs, which were fed on tinned milk, but it did not agree with their internal economy, and after a few days they died. Mr. Butter decided to march from here westward, and appointed me a rendezvous on the east shore of Lake Rudolf. Meanwhile I set off on May 8, 1903, to survey the country between Lakes Rudolf and Stefanie.

Working north towards the Hummurr mountains, we came on tracks of men and cattle; but the owners disappeared with extraordinary rapidity. Some of the boys volunteered to go in pursuit, and the next day they arrived with a man and a woman of the Arbore tribe. They had tracked them and come on their settlement at night, and managed to get on friendly terms with them. The pair whom they brought could speak a little Galla, which was a foreign language to them, and had been bribed to come with promises of many beads—the only garments affected by these people. These were the first naked race we had met, and Mohamed Hassan, afraid of shocking my susceptibilities, had them clothed before

bringing them to me to be questioned. I was much amused to see that the man was resplendent in an old shirt of Mohamed's, while the lady had to content herself with leather coverings. They did not seem at all at ease in their new clothes, and thought the whole proceeding most unnecessary. The small section of Arbore to which the couple belonged keep a few cattle and goats, and wander about in search of grazing. They build no huts of any sort. Rain causes them no more inconvenience than it does an antelope.

From here I sent my caravan due north to cut off a *détour* which I was obliged to make to visit a hill in the Hummurr range. The country we marched through was thick bush and forest, and in spite of the assurances of the Arbore that there were no elephants in this district, we soon came on a herd of quite a hundred of them feeding. On our approach they took panic and poured from the bush into a broad sandy nullah, up which they stampeded, charging and jostling each other in their anxiety to get away.

After trying to force our way through the bush, we gave it up, and followed up one of the well-graded sandy nullah-beds, which, with many twists and turns, eventually brought us to the foot of the hills. In the large trees which fringed the nullah were many well-made cylindrical wooden beehives, in one of which we found some disc-shaped honeycombs half filled with excellent honey.

The proprietors of the beehives were another section of the Arbore tribe who live in the hills. Ascending a long spur, I came upon their cultivation, the first I had seen since we were in Sidamo. They grow only a grain known in India as "juari." The Arbore had got wind of us, and we saw them decamping over adjacent spurs. Signs of peace made them by the lowland Arbore couple with us had no effect. Outside their rough shelters fires were burning and gourd cooking-utensils lying about. Rounding a sharp corner, we came on one small boy unsuspectingly pounding some grain in a bowl. The others, in their terror, had failed to warn him, and he was caught. Though terribly frightened at first, he was reassured by our Arbore couple, and given some beads and meat. On the way down the hill next day not a soul was to be seen, but we had frequent indications that some of them were moving parallel to us in the bush on either side—seeing us off the premises. On arrival in camp, which I had seen through my glasses from the top of the mountain, Mohamed showed me five elephants' tails, the former proprietors of which were lying dead in the bush. On the march the caravan had suddenly found itself in the midst of a herd of elephants, and (so Mohamed declared) they had been obliged to clear the front by shooting five elephants to let the camels through! The Somali is as keen on elephant-hunting as any one, so I had my own opinion on the subject, and reproved Muhammad. The ivory was eventually sent to Menelik.

Our march to the north end of Lake Rudolf was delayed on May 16 by the big nullah which flows from the Hummurr range south-west into Lake Rudolf. The usually dry watercourse was in flood from recent rains; the brown water swirled down, carrying and tossing about huge logs of wood. Wherever there was an obstruction, a mighty wave arose and the waters roared. The flood subsided in thirty-six hours, and as soon as it was safe for camels, we crossed.

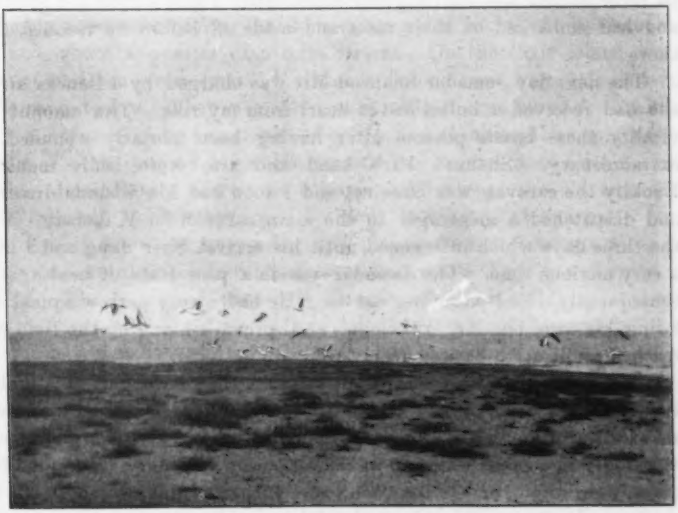
From the rocky isolated hill east of the north end of Rudolf, I was able to complete the survey as far as necessary to the north-west. North of the lake, as far as Mount Nakua, stretched a green marshy

BIG NULLAH AFTER FLOOD.

plain flooded in many places, through which the Omo river winds its way. From here I turned to the shore of Lake Rudolf.

As we travelled south, keeping in touch with the east shore of the lake, the country became more open. Our route was intersected by a series of nullahs running westwards to the lake. The shores of the lake teemed with game. I was lucky enough in four days to secure a very varied bag, consisting of a good elephant, with tusks weighing over 80 lbs. each, a fine lesser kudu, a giraffe, a zebra, a rhino, a splendid oryx, and two good lions. On May 24 I came on the main caravan camped on some rising ground about halfway down the lake. Baird had a few days before been mauled by a lion. The brute charged out from a patch of bush, and Baird's shot had failed to stop him. The next

moment the lion had knocked him down and was mauling him. Baird's fox-terrier "James," who had hitherto had a well-merited reputation for discretion, performed prodigies of valour, and positively found his way into the lion's mouth. But he was not to his majesty's taste, and was ejected, strangely enough with little hurt. Meanwhile Baird's two shikaris behaved splendidly. One caught the lion by the tail and pulled, while the other very coolly shot him through the heart. Baird had several wounds, some of them deep, but the miracle of his escape, as well as that of "James," was explained when it was seen that the lion's jaw had been broken by Baird's first shot. Luckily Wakeman was close at hand, and Baird's wounds were quickly dressed.



WATERFOWL ON LAKE RUDOLF.

Owing to his excellent state of health, his wounds took a good turn from the first. Except for this mishap, they had had grand sport with the lions, which abounded on the route they had taken from the south end of Lake Stefanie. Including my two, there were now twenty-one lions' skins in camp. Altogether eighteen lions had been killed by the party between May 7 and May 23.

Having accompanied us as far as Lake Rudolf, our Abyssinian colleagues had completed their mission, and now signified their intention of returning to their own country. Mr. Butter held a parting durbar, and made the chiefs presents of rifles, which are to an Abyssinian of more value than anything. They fired us a parting salute, to which we

replied by three volleys, and their long caravan was soon on the march north-east.

As the main caravan was obliged to halt till Baird was fit to be moved, I went on southwards to survey as big an area as possible, till I should be caught up by the rest of the party. After this Mr. Butter decided to press south to the Uganda railway as fast as possible.

The country inland was very broken and stony. The recent rains had left many pools of water, and there was grass here and there in patches, otherwise a *détour* eastwards would have been impossible. After visiting a group of isolated hills some 15 miles inland, I returned to the shore at a point where there were some small islands a few hundred yards out in the lake. From a distance I saw that there were grass huts on these islands, but the inhabitants had heard a shot I fired at a gazelle, and had embarked on their rafts and made off before we reached the shore.

The next day Jemadar Shahzad Mir was charged by a lioness after she had received a bullet in the heart from my rifle. The amount of vitality these beasts possess after having been mortally wounded is extraordinary. Shahzad Mir's hand and arm were badly mauled. Luckily the caravan was close up, and I soon had his wounds dressed, and despatched a messenger to the main caravan for Wakeman. For the three days which intervened until his arrival Sher Jang and I had a very anxious time. The Jemadar was in a poor state of health, and consequently blood-poisoning set in. He had a very narrow squeak of losing his arm, but Mr. Wakeman's skill prevailed, and by the time we reached civilization he was nearly well.

Meantime Baird had improved so much that he could sit a mule, and the main caravan had closed up. Butter and Duff had also had an exciting time with a solitary elephant, which had charged them repeatedly in a place where it was not too easy to dodge. His splendid tusks, weighing over 130 lbs. each, were Butter's trophy.

Towards the south end of the lake we came on another small inhabited island. The men were ashore hunting topi hartebeests, which abound in these parts. There was great commotion on the island when it was seen that we were standing guard over the hunters' rafts, their only means of communication with the island, which was surrounded by deep water. The hunters soon appeared, and had nothing for it but to come to terms with us. From a distance they made overtures for peace by holding up grass above their heads. We reassured them by the same sign, and they timidly approached. Finally, they picked more grass, spat on it, and presented it to us, and we were soon friends. The people are an isolated section of the Lokkobb tribe, who are either a subtribe of, or identical with, the Rendile. The Rendile country is further east, round Mount Marsabit. The chief of these people, a funny little wizened old man, talked volubly, but no one

understood a word. One of our men knew a few words of Rendile, but his attempts at conversation were not a success.

We had only two words in common "Kushumba," which means "white man," and "tambac" (tobacco), which in its slightly differing forms must be the most ubiquitous word in the world.

One of the boys placed a necklace round the old man's neck. This attention called from him the most sincere thanks, to which he gave expression by blowing a fine spray from his mouth on those round him. The circle quickly enlarged itself. Our old friend then made signals to the island, and soon a raft was crossing the strip of water towards us. I met its crew as they landed, and after spitting on a bunch of grass, I solemnly presented it to them. They took it quite as a matter of course, and returned the compliment.

After some persuasion, the old man agreed to taking me over to his island, about a quarter of a mile distant. On the little island were about a dozen grass huts. Well-made fishing-nets were laid out on the sand to dry. They use also spears made of oryx horns for fishing. I was surrounded by an astonished group, and, thinking the opportunity good, I took out my binocular camera and raised it to take a snap shot. Immediately there was a panic. All except the old man fled precipitately to their huts, and he knelt down, stroked and patted my hand as if I was an angry dog, and plainly implored me not to do it. In vain I pointed the murderous weapon towards the lake and snapped it off. The moment I turned it towards him or his children he shook with fear. So I gave it up, and tried to reassure him with some tobacco, which he accepted nervously, but immediately set to work to chew.

I then signed that I must be going, and he was evidently much relieved. It was only after exerting his authority to the full that he got a man to paddle me to the mainland. As we parted he gave me his best wishes in a spray of tobacco-juice from his mouth (my tobacco). I was so anxious that his last impressions of "Kushumba" should be good, that I took it without flinching.

Nearing the south end of the lake, we got into very bad stony ground. On Mount Kulal were another section of Lokkobb. They were very shy, but eventually I got on terms with them, and, during a long conversation conducted by signs, I was able to make a small vocabulary of their language. They made me a present of a bullock, and I gave them clasp knives and beads in return. In the evening they showed us a good track down the mountain. From the top of Mount Kulal I was able to see that far inland from the east shore of Lake Rudolf the country is barren and stony.

The ascent from the south-east corner of Lake Rudolf was steep and very stony, and the camels were glad of a day's halt when we reached the pleasant grassy valley separating the two giant mountains, Sil and

Indunumara, which supply it with perennial water. Here were more Lokkobb inhabitants, who keep cattle, sheep, and goats. The thick bush in the valley contained buffalo, giraffe, lions, and lesser kudu, while on the hills were many greater kudu. Butter secured three fine buffalo, and Duff one, and of course a couple of lions were bagged.

We marched due south up this valley, over a low watershed, and down over some rough ground into a large open plain surrounded by hills. The drainage of the north part flowed west towards Lake Sugota, while to the south a big stream in a rocky gorge took the remaining drainage south-east. Looking over the plain from Mount Suddim, as far as the eye could reach were immense herds of oryx, Grant's gazelle, and zebra, while

STEEP ASCENT FROM SOUTH END OF LAKE RUDOLF.

right under me I counted no less than fifty ostriches stalking along. Here Butter bagged the last lion shot on the trip, making up the grand total to thirty-nine. From the south of the plain a steep ascent over a big range of hills, to which we gave the name of Eland range, gave the camels the hardest work they had had on the trip. But with light loads, they climbed up places where ordinarily one would have hesitated to take a mule. As the name implies, there were many eland on this range, and some fair specimens were secured.

The hillsides were clad with forest of every conceivable shade of green. Flowers brightened the landscape, which was the most beautiful we had seen since leaving Sidamo. We crossed the watershed at its lowest point, about 8000 feet, and were here caught by a

spell of wet weather. We worked westward along the watershed, which was flat, covered with long grass, and very swampy. The cold at night was intense, and the poor camels suffered considerably.

To the south, long, easy, grass-covered spurs projected far from the watershed. The ravines separating these spurs were deep and blocked with thick bush. A long descent of three days' march through country difficult to find a way brought us to a smiling valley, which we have called Impala valley. Here these beautiful gazelle abounded, and there were, besides, wart-hog, ostriches, and Jackson's hartebeest. We fell in with some Wandorobbo hunters, who supplied us with a guide to Lake Baringo, which we reached July 7. News of our arrival was quickly taken up to the British post situated on the hills south-east of the lake, and we were met by the collector of the district, Mr. Collier, who was very surprised to see the excellent state of the caravan after such a long trip. Being rather behind our time, the authorities had feared that something might have gone wrong with us, and Mr. Collier had had search parties of Masai out far to the north for some weeks past. We, however, turned up from an unexpected direction, and had missed them.

Mr. Collier accompanied us the five days' march to Nakuru station, where we were able to learn the news of the outer world, which had been hidden from us for so long. Camels, ponies, mules, and bullocks were disposed of at Nakuru, and two days after we arrived at Mombasa, where we enjoyed the hospitality of the chief commissioner Sir Charles Eliot and Judge Cator. After a pleasant stay of three days, we caught a boat to Marseilles *viâ* Aden, where the Somalis were paid off, and from there sent over to their native land. We parted from our faithful followers with many expressions of regret. "When you are coming out again, sahib, let me know through the sirkal at Berbera, and I will come with you," were the parting words of many of them. I am looking forward to the time when I shall be able to do so.

Before the paper, the CHAIRMAN (Sir HARRY JOHNSTON) said: I have to introduce to you to-night, as author of this very interesting paper, Captain Philip Maud, on the journey from Southern Abyssinia through the little-known Galla country and the Boran country to the Eastern side of Lake Rudolf, and so southwards to the Uganda railway.

The CHAIRMAN: The paper to which you have listened with such interest has dealt with an expedition of a semi-official nature organized by Mr. Archibald Butter, who secured Captain Maud's services to take charge of the survey of the expedition. As the hour is now rather far advanced, and perhaps we ought not to detain the audience here any longer, I shall spare any remarks of my own, though I have listened to this paper with the greatest interest, and it has aroused on my part several lines of thought, and perhaps I may add the remarks I should have made, in writing. I think, therefore, I will call upon you now to pass a very hearty vote of thanks to Captain Philip Maud for his most interesting paper and the wonderful illustrations he has given us to-night.

RESCUE OF THE SWEDISH ANTARCTIC EXPEDITION.

By Lieut. JULIAN IRIZAR.

THE *Boletin del Centro Naval* of Buenos Ayres has published several interesting documents relating to the rescue of Dr. Nordenskiöld and his party and the crew of the *Antarctic*, and to the bringing home of their valuable collections by Lieut. Julian Irizar in command of the *Uruguay*, a gunboat of the Argentine Navy.

The first document is the speech of the Minister of Marine, in the course of which his Excellency was pleased to express his thanks "to the worthy President of the Geographical Society of London for the important aid he gave to Lieut. Irizar, with regard to the selection of provisions and special appliances made in Europe, in order that our expedition might be equipped in the best possible way." This praise is, however, much more due to Mr. Ernest Shackleton, to our Antarctic secretary, Mr. Cyril Longhurst, and to our associate, Mr. Crichton Somerville, of Christiania, who all did their best to give assistance to Lieut. Irizar.

Then follow three despatches from Lieut. Irizar himself. The last contains a full narrative of the voyage of the *Uruguay*, and is here translated. [The *Boletin* also contains the paper read by Dr. Nordenskiöld at Buenos Ayres on December 9, 1903, and another read by Lieut. Sobral on the 19th of the same month.]

DESPATCH OF LIEUT. IRIZAR

(*Translated by the President.*)

Buenos Ayres, December 21, 1903.

To His Excellency the Minister of Marine, Captain Don Onofre Betbeder.

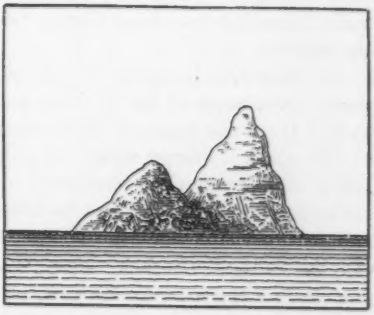
After leaving Ushuaia, and being clear of the Cape Horn archipelago, we encountered wind and sea from the south-west with a force of 5 metres per second, to take advantage of which the foresail and lower topsails were set. During November 3 the weather got worse, with wind from the north-west. The sea rose, and we were obliged to heave to on the port tack until 3 a.m. of the 4th, when we steered S. 19° E. (true). The weather had improved a little, but there were showers of sleet and hail from the south-west, with thick weather limiting the visibility to 3 miles. At noon on the 4th we sighted the first floating ice, being a stream of loose pack, which we passed through without hindrance. At 1 p.m. the first iceberg was seen ahead, measuring about 150 feet in height, and soon afterwards, the mist having cleared away, three more came in sight, of great size and prismatic shape. At

1.50 p.m., as we were in the latitude of Cape Foreland, I resolved to heave to on the starboard tack, in order to reconnoitre the land.

At 2.10 p.m., with the weather very thick, but the mist clearing a little at intervals, land was sighted ahead at a distance of 5 miles. Considering the state of the weather, with a strong wind from the north-west, it was not judged advisable to approach nearer; so we went on the other tack and hove to with her head N. 25° W. (true), waiting until the weather should improve, and admit of our standing in shore under better conditions.

In the afternoon we passed through several streams of loose pack of various sizes. During the night the weather continued bad, with a strong west-south-west gale, obliging us to alter course at every instant to avoid collisions with pieces of ice. At 2 a.m. we made sail on the port tack, steering S. 25° W. (true). At 6 we sighted the coast of King George Island, fixing the position by bearings of Capes Foreland and Melville. From that time we began to steer along the coast S. 25° W.

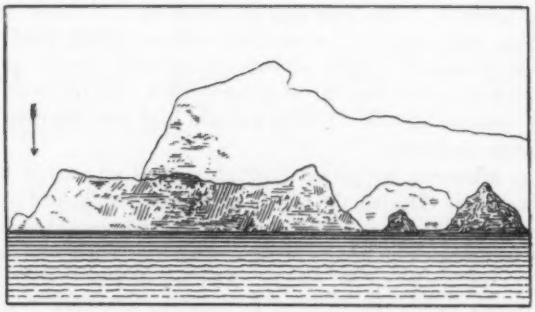
Cape Foreland appears high, and is well defined by a low point like a wall, which runs out into the sea. This point has some characteristic black patches, which serve to identify it. The islet of Melville is very easily made out, for it is seen to be open with the cape, and quite separated from it. Cape Melville is a prolongation of the coast running N. 50° W. and S. 50° E., which forms a plain with Cape Foreland to the north, and Cape Melville to the south, becoming lower from Foreland to Melville; and at about a third of the distance there is a high hill, which dominates the surrounding country. Between the Foreland and the point of Esther Bay the coast is high, a small conical hill being clearly visible in the centre. Ridley Island needs no description, as it can easily be recognized. The islets which appear between the capes are very low and black, with complete absence of snow at the time when we saw them.



MELVILLE ISLET. VIEW TO SOUTH (TRUE), 5 MILES.

Cape Melville is round on the side looking north, and runs out to sea in a peak when seen from the south-east, which joins on to the ridge of the cape by a line of steps. A little beyond the line of coast running from the Foreland a great mass of black rock was sighted, which, looking towards the north, terminates very black without any snow. In examining the islet in front of Cape Melville, it was noted that its position differs from that shown on the charts, being really 3 miles further out.

This islet is surrounded by a reef, which, when there is any sea, is made visible by the surf, and appearing to extend far towards the cape.



CAPE MELVILLE. VIEW TO SOUTH, 70° W. (TRUE), 12 MILES.

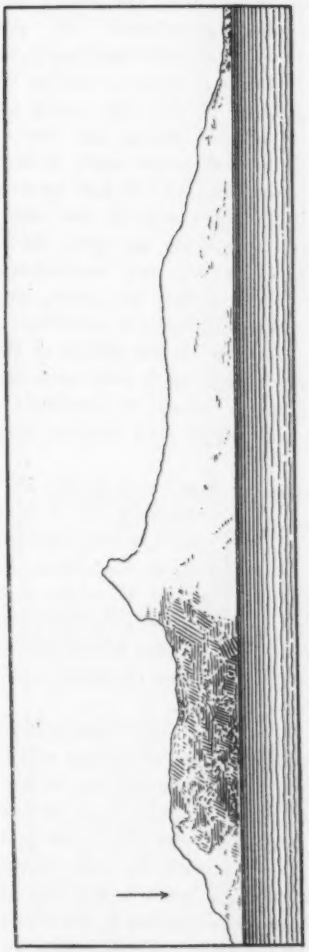
At 9.25 a.m. of the 4th we began to navigate Bransfield strait, encountering, on leaving the lee of the islands, a very high sea, which made the vessel roll heavily. The wind, though it blew light from the south-west, was taken advantage of to make more sail. Having Cape Melville of King George Island as a point of departure, we steered a course for Point Français of Joinville Island, with the object of approaching that island to a position which would enable me to see which of the two routes was best for entering Erebus and Terror Gulf—that by the strait formed by Joinville Island and Louis Philippe Land, or that to the east of Joinville Island.

Bransfield Strait seemed to be sufficiently clear of ice, or at least of pack-ice, for we could only see a great number of immense icebergs, many grounded near King George Island, and others carried along by the current.

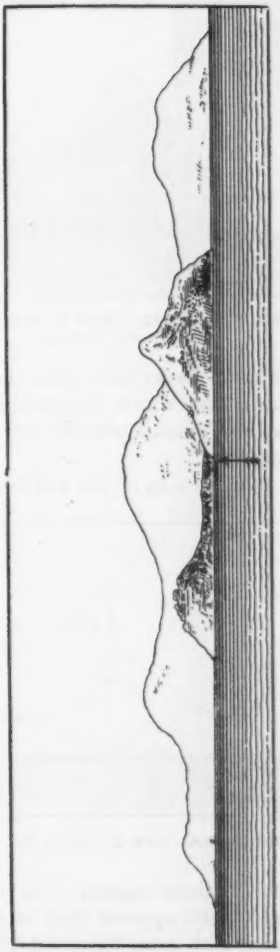
At 10.30 a.m., being on the port tack, we saw Bridgeman Island very much to the north of the position shown on the chart, so much so that at first there was reason to doubt whether it was an island or only one of the many icebergs which filed before us along the route. This island is lofty, much covered with snow, and so like the usual slope of the icebergs that it would not be difficult to mistake it for one of them. It is easily visible for a distance of 12 miles, having the scarped side of a hill facing north-east. At a distance of 10 miles (more or less) it presents the appearance shown on the sketch, bearing N. 70° E. (true).

We went on, with a clear sea, until 3 p.m., when we came to heavy pack-ice, extending in an east-and-west direction. From the crow's nest this pack seemed to widen and become heavier to the west than to the east, which was in accordance with the conclusions we derived from the direction of the winds which had prevailed during the last few days.

The winds having been strong from the north-west, it was to be expected that the ice in the channel would be pressed against the lands of Joinville and Louis Philippe. For this reason we decided on rounding the pack by navigating to the east, and entering Erebus and Terror Gulf by the



CAPE MELVILLE. VIEW TO SOUTH, 60° W. (TRUE), 5 MILES.

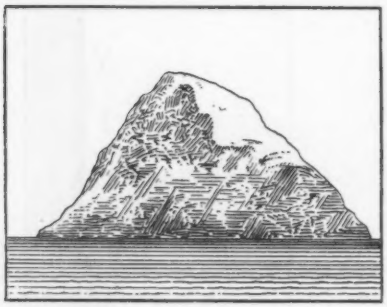


CAPE FORELAND. VIEW TO SOUTH, 20° W. (TRUE), 5 MILES.

east of Joinville Island, where we thought it most probable that we should find the sea open. The predominant winds might be expected to have driven the ice southward and to leeward of these lands.

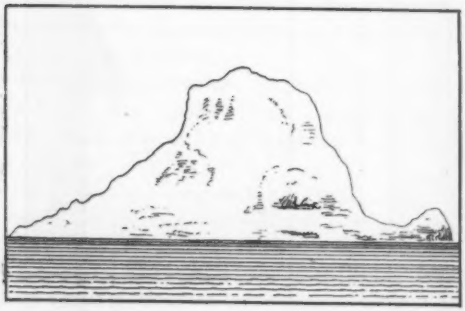
Having gone along the pack for about 12 miles on an E. $\frac{1}{4}$ N. course, we came to the end of it, and altered course to south.

At 4.45 p.m. we came to another line of pack extending south-west and north-east, sufficiently wide, but apparently not so heavy as the first. Altering course to north-east, we tried to get round it, but after proceeding for 5 miles, we resolved to enter it, as no end to it could be seen from the crow's nest. Having selected the part which seemed least heavy, we began to open a road by the bows of the ship, using the methods which are recommended under such circumstances. At 6.30 p.m. we were free of the pack, and began to navigate an open sea in which we only encountered patches easy to evade, and many icebergs of considerable size on all the points of the horizon. As at 10.30 p.m. the weather was very thick with mists and snowstorms which continually followed each other, we resolved to heave-to until it should clear, as the navigation had become very dangerous.



BRIDGMAN ISLAND. VIEW TO NORTH, 70° E. (TRUE), 12 MILES.

At 1.30 a.m. of the 6th the mist began to clear away, giving us a visibility of 3 or 4 miles, which enabled us, at that hour, to shape a south-east course in the direction of Etna Island, which came in sight at 4 a.m.

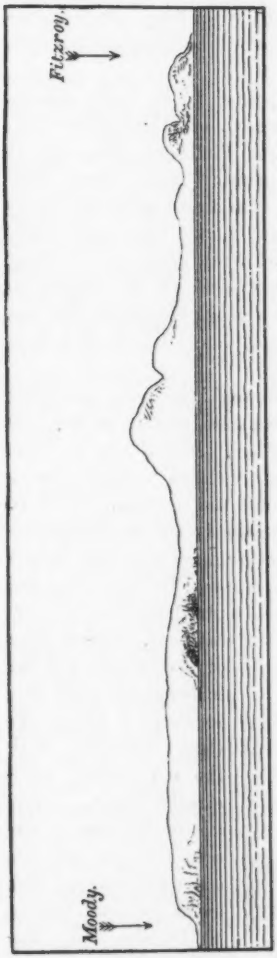


ÆTNA ISLAND. VIEW TO SOUTH, 45° E. (TRUE), 6 MILES.

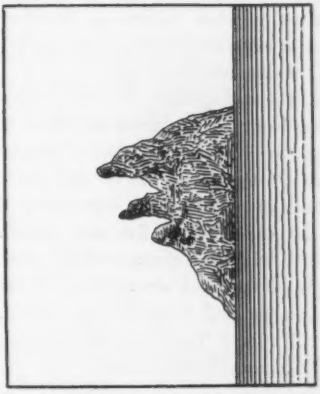
Etna Island is high and of a shape which makes it easy to distinguish from the icebergs which are met with in such abundance in these regions. The best distinguishing mark is the line of stones, which appears black at a distance, and which is due to the winds beating with great force and driving away the snow. From south-east (true), at a distance of 5 miles, the island has the appearance shown in the sketch.

We continued to steer direct for the coast, the weather being very thick, so that we could not recognize Joinville Island until we were at a distance of 3 miles. Cape Fitzroy was the first land that came

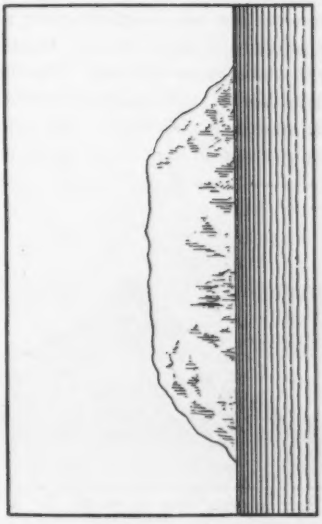
in sight. We immediately altered course to south-west to follow the coast-line, and see if it was possible to reach the gulf, leaving Danger Islands on the port side. The coast-line was between Point Moody and Cape Fitzroy, and is occupied by a glacier which comes down to the



PART OF THE COAST BETWEEN MOODY AND FITZROY. VIEW TO SOUTH, 28° W. (TRUE), 3 MILES.



ISLET OF POINT MOODY. VIEW TO SOUTH, 45° E. (TRUE), 6 MILES.



PRINCIPAL ISLE OF POINT MOODY. VIEW TO SOUTH, 45° E. (TRUE), 6 MILES.

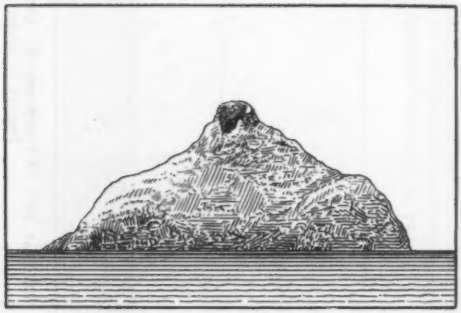
sea from a height of 200 feet. The coast-line, in place of running straight, as is shown on the chart, forms a great bay in the centre.

Cape Fitzroy is only to be noted as the northern termination of the view. It has no special characteristic. From S. 28° W. (true)

distant 3 miles, the coast appears more or less as shown in the sketch. The islands off Point Moody are all low, and in places covered with snow. The first island which lies south of Point Moody is easily distinguished, as it has close to it a curious rock which, from S. 45° E. distant 5 miles, has a form like that shown in the sketch. In all the navigation of this region an immense quantity of very large plains seem to be separated from the coast, which prove to be immense glaciers, but of inconsiderable height.

All the archipelago of Point Moody appeared to be badly placed, differing from the positions shown on the charts in bearing and distance. Taking the bearing of Point Moody on the starboard side, distant 5 miles, all the islets are on the port side, running like a chain, with a distance of about a mile separating them. The first begins at 7 miles from the cape, being flat and round. Next comes the one already described with its characteristic rock, then three more not differing much in shape and size. From Point Moody to S. 45° W. (magnetic) there is a conical islet clearly visible. We easily recognized the bay called "Firth of Tay," where the land was completely ice-covered, as it was also round Paulet Island.

From the crow's nest a very heavy pack could be seen extending north and south, which completely closed the gulf, leaving as the only entrance the one we navigated close to the shore. At 9.40 a.m. we were in the latitude of Point Moody, where we encountered no fewer than a hundred icebergs in different directions round the horizon, and all of considerable size. The passage between Point Moody and the Dangerous Islands offered no difficulty. The immense icebergs we met with in this locality gave us an idea of the great depth of the sea, for each berg did not draw less than 100 fathoms. Being clear of the islands and the icebergs, we were able to shape a course for Cape Seymour, with the sea ahead sufficiently clear. From the crow's nest it was seen that the sea was still quite covered with ice in the sound formed by Dundee and Joinville Islands.



PAULET ISLAND. VIEW TO NORTH, 50° W. (TRUE), 12 MILES.

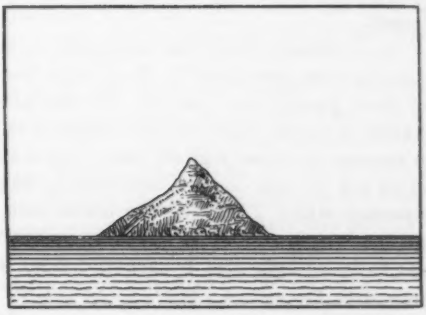
At 10 a.m. we recognized Paulet Island, which had been in sight during almost all the time that we had navigated in the gulf.

At first the navigation of the gulf was fairly easy, merely having to look out for lumps of ice and icebergs scattered over it. But as we

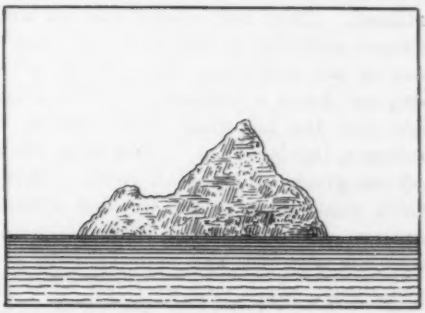
advanced the ice became more compact, and at 11 a.m. we entered a stream of pack-ice which was comparatively loose.

At 1.30 p.m. Cockburn Island and Mount Haddington were sighted. On clear days they are visible for a distance of not less than 40 miles, appearing, from the bearings indicated, in the forms shown in the sketch.

At a distance of some 8 miles north of Cockburn Island we encountered some pack-ice which seemed to block Admiralty Bay from Cape Seymour to Palmer Land, and this same pack extended towards the north from Cape Seymour, appearing to be very heavy. When we were a little nearer to Cockburn Island we could see that behind the stream of ice there was open water, and that, notwithstanding that the pack was formed of large and heavy pieces, there were narrow belts of comparatively lighter pieces through which a ship might be forced.



COCKBURN ISLAND. SOUTH, 30° W. (TRUE), 40 MILES.



MOUNT HADDINGTON. SOUTH, 30° W. (TRUE), 40 MILES.

With the precautions proper for such occasions, and at what seemed the weakest point, we put the ship's head at the pack. After forty minutes of manœuvring in it, sometimes taking advantage of spaces between ice-blocks, sometimes forcing a way with the bows, we continued to work our way towards Cape Seymour. At 6.40 we arrived at its west end, where we had to stop the engine, for we found that beyond the cape the sea was completely frozen over. On the other side, west of the cape, the pack was close along the shore, extending to the north-east as far as could be seen from the top. Under these circumstances we sought for a secure place for anchoring, in order to begin our first explorations next day, with the object of reaching Snow Hill. When the lead gave us 9 fathoms we anchored, with a good bottom of clay and small shells.

As soon as we had anchored we examined the ice of the floe, finding that it was 2 feet above the water, with 7 to 9 feet of depth. This enabled us to get out our sledge in safety.

In the same night all necessary arrangements were made to despatch a party at dawn, consisting of the ensign Fliess, Dr. Gorrochategui, and a sailor. They were to land on Seymour Island, and proceed in an easterly direction, with the object of reaching the provision depôt and obtaining any notices that might be left there, and also to bring back information respecting the state of the ice in that part of Seymour Island.

In conformity with this arrangement, the party landed early next morning with provisions for three days, and with everything necessary for their journey over the ice. It was also decided to take the precaution of roping them in alpine fashion, to guard against an accident so common in these regions, caused by a fall into a crevice in the ice. So as not to lose time, I immediately began to get ready a sledge excursion which I intended to make, with one of the sledges which remained on board, to be dragged by ourselves. In this excursion I was to be accompanied by Lieut. Yalour and a sailor. After a trial made with the sledge loaded, we calculated that we could easily reach Snow Hill in two days.

In the afternoon of the 7th, Lieut. Fliess and Dr. Gorrochategui returned. They had crossed the ice and reached Seymour Island without difficulty, proceeded to the eastward, and, after examining part of the coast, they had come to a beach easily accessible by a boat, and found a boat-hook nailed to a heap of stones. This boat-hook had the following inscriptions on it. "Jason, 1899. Sobral, Anderson, October, 1903." The cairn was taken down stone by stone, and the ground dug up all round without finding any other notice which would have shown us what direction to take as regards the explorers of the *Antarctic*. Near the cairn some comparatively fresh footprints were seen and followed as far as some ground covered with hard stones, where they were lost. The party also reported that the north-west wind had blown the ice from Seymour Island towards the south, and that it was possible to pass to the end of the island in the ship.

The fact of not having found any notice in the cairn discovered by Fliess made me think that they had not arrived at the depôt, which gave rise to a number of conjectures.

The names of Sobral and Anderson were written in the previous month; consequently those gentlemen were alive at that date. Anderson belonged to the crew of the *Antarctic*. What was he doing at Snow Hill? Had they come in the *Antarctic* and taken away all the dwellers at the winter station? or had the *Antarctic* been shipwrecked and her crew taken refuge at the winter station?

With these doubts, I resolved, so as to reach Snow Hill more expeditiously, to start at dawn and examine the coast of Seymour Island to the east, which, according to the report of the sledge travellers, was possible, and, in case of finding nothing on the island, to continue the excursion by sledge to Snow Hill. This would enable me to reach the winter station with more speed and great saving of fatigue.

At midnight of the 7th the wind changed to the south, and the ice, driven by the wind and current, began completely to block our anchorage. With the speed which the occasion required, we weighed, and, not losing a second, we were able to avoid being beset, perhaps for several weeks. We shaped a course to the eastward, where the same wind had left an open sea.

With the engine at half speed, and taking all needful precautions, we began to examine the coast of Seymour Island. At 4 p.m., while standing off the island to get clear of some grounded icebergs, and an accumulation of pack-ice, we saw something like a tent immensely magnified by the refraction. Having cleared the icebergs we steered for it, and soon afterwards were convinced that it really was one. At a convenient distance from the beach the ship was stopped, and while she remained under steam, I went in the whale-boat, with an officer, to see what there was in the tent.

We arrived without seeing any sign of life, but in answer to our call we found that it was inhabited, to our great joy, by two men of the Nordenskiöld expedition, who, profoundly moved, gave us the information so much desired. We heard from them that Dr. Nordenskiöld and his companions at Snow Hill were well; that three men of the *Antarctic* had reached that station, having been left in the previous year at Mount Bransfield; that the ship left that place on December 29, 1902, with the intention of reaching Cape Seymour by rounding the peak to the east, but that there had been no further news of her, and it was supposed that she must have met with some serious accident.

I immediately resolved to proceed to the winter station at Snow Hill, whence the distance was 12 miles, and after having given instructions to my second in command to wait with the ship, I proceeded on foot with Lieut. Yalour as my companion; also Dr. Bodman and the cook of the winter station, being the two we found in the tent. We arrived after seven hours, and Dr. Nordenskiöld, Lieut. Sobral, and the other members of the wintering party came out to meet us. Here they confirmed the news which Dr. Bodman had given us during the march.

In obedience to my instructions, I informed Dr. Nordenskiöld that I had orders from your Excellency to extend to him every kind of help from what we had on board, and that, if he desired to abandon the winter station, the vessel was at his disposal to take him to the Argentine coast, after a search in all probable places where we should be likely to find the crew of the *Antarctic*.

Dr. Nordenskiöld was profoundly rejoiced at the help which our Government had sent. He accepted the offer to embark on board the *Uruguay* with all his people, to return to Buenos Ayres after a search for the crew of the *Antarctic*, in conformity with the plan that was agreed to between us.

In order not to lose time, the embarkation ought to be commenced on the following day. Having made these arrangements, I at once returned on board, and I took the ship near to the channel between Seymour Island and Snow Hill. As it was frozen over, it was the most convenient place for bringing the luggage of the wintering party on board, which would be conveyed thus far on a sledge.

At 2 a.m. of the following day, after having studied the best course to pursue in searching for the crew of the *Antarctic*, I sent my second in command to the wintering station, to explain my views to Dr. Nordenskiöld, so that he might leave instructions there respecting the route we intended to follow, to serve as a guide in case either of the other two expeditions should arrive, which at our departure also intended to come with help for Dr. Nordenskiöld. On arriving at the station, Lieut. Hermelo was astonished by the good news that Captain Larsen and six of his crew had arrived, and that the rest were on Poulet Island.

Nearly at the same time I experienced the emotional surprise of the arrival of Captain Larsen, who had crossed Hermelo by a different route.

From him I learnt that in December, 1902, he had made various attempts to reach the station at Snow Hill, but, owing to the bad season, he had found all routes blocked by heavy packs. He therefore landed Dr. Anderson, Lieut. Duse, and one man, to proceed with a sledge from Bansfield to Snow Hill, to inform Dr. Nordenskiöld of the impossible obstacles which prevented the ship from reaching him, and suggesting the convenience of embarking at Bransfield. This party met with superhuman difficulties, and was obliged to return to winter, under wretched conditions, at the foot of Mount Bransfield.

The *Antarctic* took a north-east course, with the intention of reaching the coast north of Joinville Island, so as to enter the gulf of Erebus and Terror by the east, hoping on that side to reach the station of Snow Hill. On December 31, at a distance of about 45 miles from Point Français, the ship was beset in the pack, and drifted in the ice towards Point Moody, passing inside the Dangerous Islands. On January 4 one of the blocks of ice destroyed the poop, smashed the rudder and the stern-post up to the 12-feet mark. In this condition she continued to drift about, and on February 6 she was about 9 miles north-east of Cape Seymour. A hard gale began to blow from the south-east, carrying her to the north-west until the 12th, when the ice opened and formed a channel. The *Antarctic* filled with water, and

had to be abandoned 20 miles south-east of Paulet Island, where the depth was 200 fathoms.

After sixteen days of constant hardship and misery, dragging more than 7 tons of weight over the pack, the crew succeeded in reaching Paulet Island. A stone house was at once built, where they passed the winter, living on seal-flesh. A sailor, who suffered from disease of the heart, died during the winter. On the arrival of spring, Larsen took a boat and five men, and reached the point where Anderson and Duse had landed, finding a notice they had left, informing him that they had gone on to Snow Hill. He also intended to reach the winter station by November 6. On the 8th, after rowing without rest, they reached Cockburn Island, and began a march over the ice on foot, finally arriving in the night of the 11th, and causing Dr. Nordenskiöld very natural surprise, as well as his companions. They gave him the news of our arrival, and that we had only left them a few hours before.

With the arrival of Captain Larsen our plans were much simplified, for he also was to go back with his crew on board the *Uruguay*. We determined in consequence, as soon as we had taken all on board from Snow Hill, to proceed at once to Paulet Island, to take on board the crew of the *Antarctic*, and commence our return.

Unluckily, on the 9th the wind, which had been light from the north-west, freshened suddenly, and by night it was blowing a gale. The whale-boat, which was made fast astern, cut the painter and went adrift. Immediately the launch, with eight men under Lieut. Fliess, was sent after her, but when he returned with the whale-boat the wind increased, obliging him to go to the coast east of Snow Hill, so as not to be driven away to the south. When we saw the situation of the boats, we immediately weighed, placing the ship in front of where they were until 1 a.m. of the 10th, when the wind went down, and they were able to return with the launch.

In the bay where the boats had taken refuge, the wind drove in several pieces of ice, and Lieut. Fliess, with his eight men, had to struggle with them continuously to save the boats. Their strength was not sufficient to prevent the whale-boat from being smashed between the blocks of ice. They only returned with the launch, being quite exhausted by fourteen hours' hard work among the ice.

At 4 p.m. of the 10th we completed the embarkation of Dr. Nordenskiöld and his companions with their collections, and the other luggage they considered it necessary to take away. We then went, with the ship, to the part of Seymour Island where the depôt was, with the object of recovering a collection of fossils which had been made by Dr. Anderson.

Considering that Erebus and Terror Gulf will be the landfall for any distressed expedition in this part of the Antarctic regions, I thought it would be useful and humane to have depôts of provisions at the most

accessible points. After consulting Dr. Nordenskiöld and Captain Larsen, I selected Seymour and Paulet islands as the places where depôts should be formed.

The Seymour Island depôt is where the depôt of the Nordenskiöld expedition had previously been. It is sufficiently conspicuous, and has a cairn with a long pole. It was covered with tarpaulins and stones, securing it from the strongest winds and snowfalls. On a board fastened to a pole on the side of the depôt there is a cylinder with a list of the provisions as follows:—

960	rations	of preserved meat.
2517	,,	preserved vegetables.
3750	,,	dried pulses.
240	,,	preserved fruit.
266	,,	pemmican.
200	,,	biscuit.
1200	,,	milk and butter.
750	,,	sugar.
1800	,,	tea.
1500	,,	salt.
2	boxes	of kerosene.
440	boxes	of lucifer matches.

Having formed the depôt on Seymour Island and recovered the collection of fossils, we shaped a course for Paulet Island. In the Erebus and Terror Gulf we met with several patches of stream ice, which were passed without difficulty, and early on the 11th we arrived at the place where the crew of the *Antarctic* had passed the winter.

Paulet Island is easily recognized by its peculiar shape, which appears to be that of an extinct volcano, the coast being surrounded by ice. The stone house of the shipwrecked crew is situated on the north-west side, in a depression of the land. To reach it, it is necessary to land on the ice more to the west, as the coast is without a beach, and there is little open water. The geological formation appears to be entirely volcanic. Penguins are abundant, and there are some seals. During all the time that the ship was in front of the house we had to keep steering clear of ice, which the wind and current kept in continual motion.

We set up a wooden cross over the grave of the sailor who died in the winter, and when every one had been embarked, with the property of Captain Larsen and the men, we left a large depôt of provisions in the stone house, as follows:—

2000	rations	of preserved meat.
8514	,,	preserved vegetables.
4500	,,	dried pulses.
480	,,	preserved fruit.

798 rations of pemmican.
3180 „ tea and chocolate.
8000 „ salt.
600 „ biscuit.
2560 „ milk and butter.
3000 „ sugar.
10 boxes of kerosene.
600 „ lucifer matches.
12 bottles of spirits.

A record was left stating our proceedings, and that we intended, on leaving Paulet Island, to sail between Joinville and Louis Philippe, picking up there the collection of fossils left by Dr. Anderson at his wintering station, and then passing by New Year and King George's Islands.

Including the crew of the *Antarctic*, the number of persons taken on board the *Uruguay* was twenty-eight—

Dr. Otto Nordenskiöld.
Captain Larsen.
Lieut. José K. Sobral.
Dr. Anderson (*geologist*).
Dr. Erik Ekelof.
Dr. K. A. Anderson (*botanist*).
Lieut. L. A. Duse.
Carlos Scotsberg (*botanist*).
Dr. Bodman (*meteorologist*).
Andres Carisen (*engineer*).
L. Andreasen, H. Haskum, Axel Reinholtz } (*pilots*).
And 15 men.

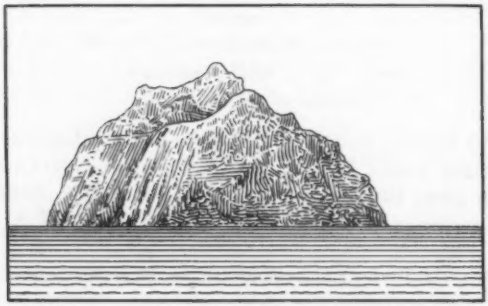
All that was possible was done to make them comfortable. The officers gladly gave up their berths and cabins to accommodate Dr. Nordenskiöld, Captain Larsen, and the scientific staff. The men of the *Antarctic* were given the mattresses of our sailors, who only kept the hammocks. As the explorers were in want of clothes, they were all supplied with two suits of inner and one of outer clothing.

Dr. Nordenskiöld having informed me that during the previous winter Dr. Anderson and Lieut. Duse had made an important collection of fossils at Mount Bransfield, I resolved to make for Bransfield Strait, passing between Joinville Island and Louis Philippe. Although this would cause some loss of time, owing to the state of the ice round Dundee Island, on the other hand it would enable us to recover the collections.

From Paulet Island we steered south-west to get clear of the pack round Dundee Island, and we then found a channel which enabled us to reach Mount Bransfield without difficulty, between Cape Scrymgeour and an island without name on the English chart.

At about 1 p.m. on the same 11th of November we reached a bay in front of Mount Bransfield, stopped the engines, and sent a boat with some of the Swedish explorers to recover the collection left there by

Dr. Anderson. At 5 p.m., these gentlemen having returned on board, we began to navigate across Bransfield Strait, intending to pass to the east of King George's Island. During all the afternoon of the 18th, and until we were well clear of the islands to the north of Louis



ISLA NAVIDAD (CHRISTMAS ISLAND), LARSEN (WITHOUT NAME ON ENGLISH CHART). VIEW TO NORTH, 50° W. (TRUE), 6 MILES.

Philippe land, we met with loose pack-ice and innumerable icebergs, which obliged us to keep a constant look-out to avoid them. At 8.20 p.m. the sea began to be clear, and it was possible to shape a course for Cape Melville, N. 10° W. (true). At 7.10 a.m. on the 12th, we sighted the above-mentioned cape when on the port tack, and from that time we began to experience strong winds from the north-west, which increased as we advanced. At 3.25 p.m. the sea was very high and the wind strong, so that we were obliged to heave to, heading N. 5° W. (true) on the port tack. In the night both wind and sea increased in violence.

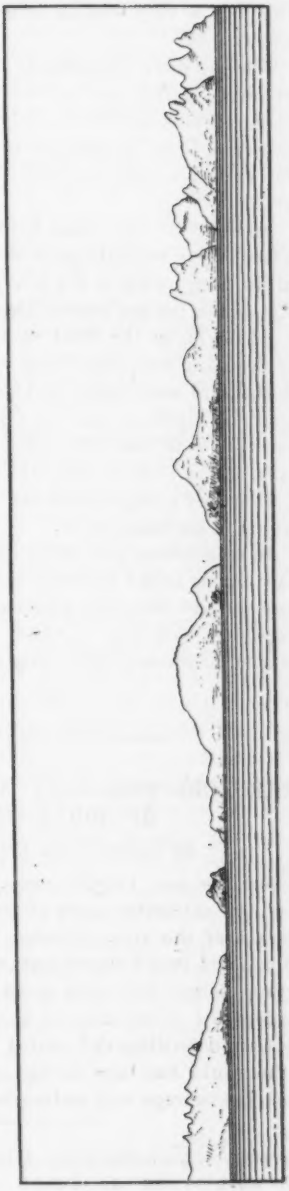
The wind continued to blow very hard (15 metres per second), so that we had to shorten sail to fore and mizzen staysails. The sea was very high, making the ship roll heavily to 40°. The bad weather continued through the night of the 12th, and the day and night of the 13th. In the morning of the 14th the wind went round to south-west, blowing with a force of 15 metres per second. After noon the wind shifted to west, and blew with less force; but at 6 p.m. it freshened again, with a rapidly falling barometer, and storms of snow and hail. At sunset it began to blow furiously from west to south-west, and at 1 a.m of the 15th it reached the extraordinary force of 27 metres per second.

At dawn of the 15th it was seen that the main mast was sprung at the tressle-trees, where the shrouds rest. Immediately steps were taken to remedy such grave damage, but it was practically impossible, owing to the way in which the mast had been injured. The topmast with its yards was supported only by the heel and the backstays, which were well set up. Soon afterwards it was seen that similar damage

had been done to the foremast. By this time the weather had improved but there was still a high sea. Until 9 a.m. the topmasts remained without falling, but, seeing that this was inevitable, it was resolved to let go the backstays.

The men were all at their stations, and when the backstays were let go, the topmasts fell, the main to starboard, and the fore to port, remaining suspended with the yards, all having to be cleared. During this difficult and tedious manœuvre the engine was stopped, to prevent any line from fouling the screw. This went on until noon, when everything was clear, and we were able to go ahead and continue the navigation, the weather threatening. During the 16th wind was from north-west and south-west—force from 15 to 18 metres per second, and this continued until the 17th at 7.20 p.m., when we sighted Cape St. John on Staten Island.

At 10 p.m. we stood in for the lighthouse of Observatory Island, where we stopped the engine until 4 a.m. We were then in front of the landfall we sought, where Lieut. Sobral and Dr. Bodman landed to compare the magnetic instruments at the observatory. We also left nine Greenland dogs there, which Dr. Nordenskiöld had kindly given to me. These dogs, perfectly trained, had done good service with the sledges from the Snow Hill station. Expecting that our country might find them useful in the future, and New Year Island being, in my judgment, the best place for them to be kept and to breed, I resolved to leave them there until your Excellency may make other arrangements. The



GENERAL VIEW OF THE STRAITS BETWEEN JOINVILLE AND LOUIS PHILIPPE LAND. SOUTH, 40° E., 7 MILES.

stay at the observatory was made at the request of Dr. Nordenskiöld, who took a very special interest in the comparison of the magnetic instruments.

On the same morning, at 7, we anchored at Port Cook, where we remained until 4 a.m. of the 20th, when we returned to Observatory Island to re-embark Lieut. Sobral and Dr. Bodman. At 7 a.m. we sailed for Santa Cruz, in order to comply with a request of Dr. Nordenskiöld, who wished to communicate with his country by telegram as soon as possible.

In the first day's runs between the island and Santa Cruz we had to face strong westerly gales with a velocity of 7 to 24 metres per second. On the 21st, owing to the heavy sea, we had to heave to for three hours, after which the sea became more moderate.

At 6 p.m. on the 22nd we anchored at Santa Cruz, whence I communicated to your Excellency by telegram an extract from this despatch On the 23rd we weighed and stood on a N. 44° E. (true) course, with the object of sighting the lighthouse on Penguin Island. Bad weather continued until the 26th, when the wind went down at sunset, and at 1 a.m. on the 29th we made the Medanos lighthouse. Finally, at 11 a.m. of December 1 we reached the roads, and, escorted by many steamers, arrived in the north basin.

In concluding this despatch, I desire to report to your Excellency the valuable help I received, throughout the voyage, from the second in command and the other officers, who, without exception, have zealously co-operated with me. I would also represent the excellent conduct of the men, to whom I desire to give the highest praise.

JULIAN IRIZAR.

THE ACRE TERRITORY AND THE CAOUTCHOUC REGION OF SOUTH-WESTERN AMAZONIA.*

By Colonel G. E. CHURCH, Vice-President R.G.S.

DURING the past twenty years, the abundant output of india-rubber from the extensive region at the headwaters of the Purús and Madeira affluents of the river Amazon has made it imperative that Brazil, Bolivia, and Perú † should not only define their boundary-lines without further delay, but open some comparatively easy avenue for the development of an area of South America which probably has no superior in fertility and varied natural resources. Thus far, no trade in the world has been carried on under equal difficulties; and it has taxed the courage and endurance of those engaged in it to an almost

* Map, p. 704.

† These three countries export about two-thirds yearly of all the rubber produced in the world, the total value of which is about £20,000,000.

incredible extent. It represents a continuous struggle, under conditions which every year impose greater loss of health, life, and material than an active military campaign, and the human suffering is appalling. It has had a choice of three principal routes. The main one is *viâ* the 270 miles of cataracts and rapids of the river Madeira, the last of which, San Antonio, 1533 miles from the Atlantic, is accessible to sea-going vessels. The loss of canoe-freights among the rocky obstructions and reefs of the Madeira has been great. Nevertheless, the larger part of northern Bolivia has sought this dangerous avenue. At times, goods have been stored at San Antonio for many months, awaiting transportation up-stream; for canoe-men are limited in number, and almost unobtainable. A second route, only available for about five months yearly, leads overland through the hills, forests, and swamps, which for 70 to 90 miles, according to the road taken, separate the river Mayutata from the Aquiry (or Acre) branch of the Purús.* By about 400 miles of canoe navigation on the Aquiry, and 1100 by steam on the extremely serpentine Purús, the Amazon is reached approximately 1000 miles above Pará. By a third track, Indian carriers, with loads of 50 pounds each, scale the Andes to a height of 15,000 feet, reach the table-lands, and transfer their burdens to mules which descend to the Pacific coast port of Mollendo. The Indian then returns with supplies for the rubber-collectors. The mule has by far the easier task imposed upon him.

As early as 1871, when in northern Bolivia, the writer learned that to the north-west the country was rich in rubber-forests, which, near Cavinas, were already being worked; but the lower Beni and the Mayu-tata valley had not then been fully explored. In 1880, and the following year, Dr. Heath made a daring descent of the Beni in a rotten canoe, and mapped the river† from Reyes to its confluence with the Mamoré, locating *en route* the mouth of the great Mayu-tata, or "Madre de Dios." His exploration led to the opening of the lower Beni, Mayu-tata, Orton, Abuná, and many minor streams, the valleys of which were soon sought by Bolivians, Brazilians, and Portuguese. It was found that the rubber they produced was the finest and most valuable of the Amazon valley. Labour, however, was difficult to obtain. After stripping the ancient Jesuit missions of the Mojos and Beni of their last man, unsuccessful effort was made to introduce Paraguayan Indians, by an almost intransitable overland track connecting the Guaporé branch of the Madeira with the Paraná affluent of the Rio de la Plata, so large were the gains which accrued to the collectors and shippers of the precious gum.

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* This is the track opened in 1887 by an energetic Brazilian, Colonel Labre. See *Proceedings, R.G.S.*, August, 1889.

† See *Proceedings R.G.S.*, 1883.

In 1872 attention was called to the abundance of rubber trees in the valley of the Purús river, and the adventurous Brazilian population of the middle Amazon valley began to push up that stream and occupy the lands. By 1878 it was estimated that about 8000 had settled in the valley; but the following year a great influx of labourers took place from the drought-stricken Brazilian province of Ceará, and now the population is about 60,000. Soon the Brazilian pioneers crossed the boundary-line into Bolivia, and overran the forests of the Aquiry and other tributaries of the Purús, until, by 1884, they largely exceeded in number the Bolivian occupants. It was in that year that Brazil denounced its treaty of 1867 with Bolivia.

The sequence of events which led up to this act is an interesting chapter in the history of South America. To carry out one of the principal objects of that treaty, Brazil granted large and liberal concessions for the building of a railway to avoid the falls of the Madeira. When a locomotive was running over the first section of the railway and the works were well in progress, Bolivia frustrated their completion and endeavoured to divert the company's funds to the pressing needs of the national exchequer; this resulted in the ruin and abandonment of the enterprise.

The Imperial Government of Brazil found it difficult to regard this action of her neighbour with indifference, for it struck a blow at the development of the Amazon valley that was regretted by all of the independent states the Atlantic slopes of which are drained by great rivers which are more or less obstructed by obstacles such as those which cut off Bolivia from access to the ocean.

Be it said to the credit of the latter state that, under a more advanced government, it soon realized its unfortunate mistake, and early in 1882 proposed and concluded a special convention with Brazil, called "Marginal Railway of the rivers Madeira and Mamoré," therein agreeing that "the necessity of the railway was already recognized, and, to satisfy it, the Imperial Government had conceded a privilege to Colonel Church in 1870." Brazil, offended and wary, only allowed certain advantages for Bolivian trade, and (Article 6) "the present treaty will come into force when the railway may be opened to traffic, and for fifty years thereafter."

A statement had been made general that the railway was "impracticable." This had an adverse influence upon Brazilian public works of a similar character, which was calculated to greatly retard the development of the country. Hence it became of importance to prove the perfect practicability of the line, and therefore Brazil, in 1882, sent a large corps of Government engineers to study the district, verify the previous numerous surveys, and make an independent estimate of the cost of carrying out the enterprise. At the end of two years the chief engineer of the expedition, Senhor Pinkas, in his published report,

stated that the railway was perfectly feasible, and could be constructed and equipped for £873,671, including 10 per cent. for contingencies.

Brazil was aware of the fact that, when the railway company was forced to abandon the works, it had in cash in the Bank of England £852,000, which was supplemented by a Brazilian guarantee of £400,000 in event of the latter being required.

On September 6, 1884, Brazil denounced its "Treaty of Limits, Commerce and Navigation" above mentioned with Bolivia, except that portion relating to limits.*

The friendly relations between the two countries were submitted to increased tension. The pioneers of the Acre seemed to have no respect for a boundary-line on the other side of which they could see an india-rubber tree, and the wave of population constantly surged southward and up the river Acre. In the course of a few years it threatened to cross the divide between the valleys of the Purús and Mayu-tata.

To safeguard its territory, Bolivia, in 1890, created the Delegations of the Acre, Purús, and "Madre de Dios," and after fruitless negotiations with Brazil for several years, to adjust the terms of a new commercial treaty, established a custom-house, in January, 1899, at Puerto Alonso (now Puerto Acre), upon the Bolivian side of the frontier as defined in 1867. This gave rise to a warm diplomatic correspondence between the two republics, accentuated, locally, by the efforts of Manaos to enjoy the growing trade and its revenues. The Brazilian settlers on the Purús, uncontrolled and probably then uncontrollable by any established authority, broke up the custom-house just four months from its establishment.

Then followed, in the depths of the Amazonian forests, a movement which takes us back to the days when the early *conquistadores* defined the limits of their respective territorial grants as they, not the king, understood them. An "Independent State of the Acre" was proclaimed; the bold leader, a Spaniard named Luis Gálvez, with twenty-five followers of various nationalities, ascended the Purús and, on July 15, 1899, caused himself to be named President, outlined the frontiers of his dominion, adopted laws for its government, *especially for the collection of its revenues*, and hoisted a national flag. Vast wealth loomed large upon the horizon of his filibustering hopes, for the sap that ran from the trees which covered the immense swamps of the Purús and its

* This treaty, dated March 27, 1867, states in its preamble that it is to promote communication and commerce across the common frontier and by the rivers. Of its thirty articles, fifteen are dedicated to the subject of fluvial trade between the two nations, and Art. 9 concedes to Bolivia the use of any road which may be built to avoid the falls of the Madeira. On October 10 following the signature of the treaty, Brazil sent two German engineers, J. and F. Keller, to explore and map the entire line of falls, and report upon the best means to avoid them by a feasible commercial route. Their report was published in 1869.

Aquiry branch was liquid gold. He believed that no adequate force could be sent from the Bolivian Andes to quell the *pronunciamiento*, and that the merchants of Manaos who backed him were sufficiently powerful at Rio de Janeiro to prevent Brazil from doing justice. He was mistaken in both cases; only a Peruvian viceroy could exclaim, "God is high, the king is far, I am master here!" Very soon the freebooters began to quarrel over the plunder of the customs imposts, and split into several parties under separate leaders who fought for supremacy. "President" Gálvez was temporarily replaced by a Colonel Braga, whose education was limited to a recognition of the "fat letters" of the alphabet, as the ignorant people of the locality called them; but, *en revanche*, he possessed large rubber estates, *owned* many labourers, and had a goodly store of rifles and ammunition. The result of the long scramble for the rich revenues of the Acre was the occupation of the territory by a small Bolivian force, the restoration of order, and the establishment at Puerto Alonzo of a Brazilian Consulate. But Bolivia, realizing that its hold on the great rubber region (much larger than England) was extremely precarious, conceived the idea of introducing a foreign element into the quarrel, through concessions which it granted to an Anglo-American "Syndicato Boliviano" in December, 1901. The Syndicate was organized in New York with a *nominal* capital. It was to have the fiscal and police administration of the Acre, and retain 40 per cent. of its revenues, Bolivia to be paid the remaining 60 per cent. and to remain the sovereign power. Other immense privileges were conceded to the syndicate. But it did nothing with its concessions. As well might it have tried to work a *rancho* in the moon. It only served to alarm Brazil, where it was considered by the Government as seeking to establish, under the powerful protection of the United States of North America, an *imperium in imperio*, which the Brazilian minister for foreign affairs characterized as "a first attempt to introduce on our continent the African and Asiatic system of chartered companies, armed with almost sovereign powers." To eliminate this shadow from the already stormy situation, Brazil bought out the concessions of the "Bolivian Syndicate," paying therefor £110,000 cash, although, intrinsically, they were valueless except as a political weapon.

The state of Amazonas became much excited over these concessions, the Acre again broke into revolt, the Bolivian authorities at Puerto Alonso were beset, and, after a six months' siege, were driven out; but the Government at La Paz organized another military expedition, which, under the able and energetic leadership of President Pando, left that capital in January, 1903, and, after terrible hardships and sufferings, demanding heroic endurance and fortitude, during a march of 800 miles among the gorges of the Andes, and the forests and rivers, reached the confines of the Acre the following month of March. But the Brazilian Government had also taken action and dispatched a

naval and military contingent to the scene of the conflict, where its commander took possession of the territory. The dispute was daily growing in magnitude; two hostile forces were facing each other in the wilds of the Amazon, and threatened to involve Brazil in a war with Bolivia, and perhaps with Perú, which also claimed that her boundaries extended far to the eastward and comprehended a great part of the valley of the Juruá, Purús, and other streams, even as far as the river Madeira, under the Treaty of San Ildefonso in 1777, which, however, was never ratified by Portugal.

Under these critical circumstances, Brazil and Bolivia agreed to a *modus vivendi*, signed at La Paz on March 21, 1903, by which the troops of the former were to occupy the Acre, and those of the latter the banks of the river Orton, with outposts on the Abuná—Brazil to collect the export duties on Acre rubber and divide them equally with Bolivia, and if, at the termination of four months, they had not reached a definitive and direct agreement regarding the questions at issue, these were to be submitted to arbitration.

Happily, the two countries have settled their differences by a new treaty, signed at Petropolis, November 17, 1903, and very recently ratified by both republics.

It was also natural that the attention of Perú should be attracted to the rich fields which were being opened on the undefined borders of her Amazon slope. It required the hard blessing of the war with Chile to make Perú comprehend that she possessed incalculable resources to replace the exhausted guano deposits of the Chincha islands and the lost nitrate beds of the Tarapacá desert. Now, turning her eyes towards the east, and animated by that indomitable courage which characterizes the Spanish blood, she proposes to settle her boundary-lines with Brazil and Bolivia, and make effort to connect some of her Andean railways with navigable points upon the tributaries of the Amazon, such as the Marañon, Ucayali, Juruá, Purús,* and Mayu-tata, but more especially with the latter, the sources of which, pillowed among the snows of the Andes, drain the mountain-sides east of Cuzco, between Lat. 11° and 14°·30, gathering their wealth of waters into a mighty stream to swell the volume of the Madeira, and make it one of the gigantic rivers of the world.

No section of the Amazon valley equals in interest that drained by the Mayu-tata, the Amaru-mayu of the Ingas; none has such a history of endless romance, and none has been found so inaccessible. The whole region palpitates with mystery; Ingas have lost armies in it,

* In Perú there are five portages in use between the Ucayali and Juruá rivers. The principal one, which has considerable traffic, connects the Tamaya affluent of the former with the Amuenga branch of the latter. From the Urubamba tributary of the Ucayali, by way of the river Shepahua, a short portage may be reached leading to the Cuja, which unites with the Chandless to form the Purús.

and in viceregal days it swallowed many a Spanish expedition, whether of missionaries or of *conquistadores*. Since colonial times, those whom it has lured into its fascinating and savage wilds have paid heavily for their temerity.

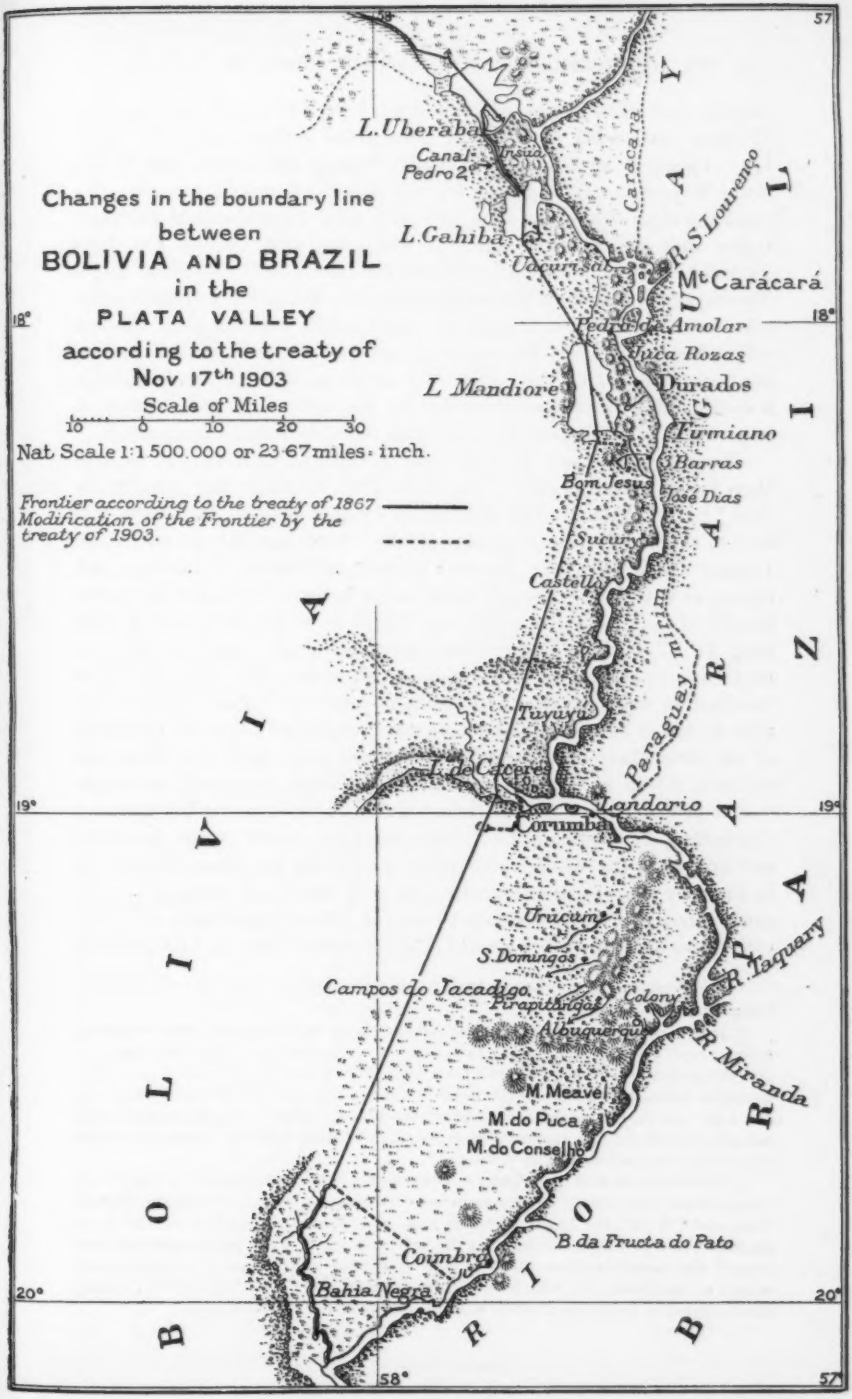
Between the upper waters of the Urubamba and those of the Mayu-tata there are now four known portages, probably used by the Indians from time immemorial—one *viâ* the Camisea, another by the Serjali, a third by the Jimblijinjileri branch of the Serjali, and the fourth by the upper Mishahua. A report upon these has just been published by the "Junta de vias Fluviales," a department of the Peruvian Government organized in 1901. It is called "El Istmo de Fitz-Carrald," and, with a further report by the same Junta on "Vias del Pacifico al Madre de Dios," forms a valuable treatise upon the whole Mayu-tata river system and its accessibility from the west.

During the dispute between Bolivia and Brazil regarding the Acre territory, every attempt to facilitate and cheapen transportation was hailed with enthusiasm by the settlers occupying the Mayu-tata and its tributaries. It was not believed that the valley was commercially accessible from the Amazon by ascending its Ucayali branch and crossing the mountain divide. At this time, however, a rubber-collector, Carlos Fermin Fitz-Carrald,* a Peruvian, had his *barraca* at the junction of the Tambo and Urubamba affluents of the Ucayali. Desirous of avoiding the long and tedious voyage between Manaos and his estate *viâ* Iquitos, he sent a few Piros Indians up the Ucuyali to see if they could find a practicable track between its Camisea branch and the sources of the river Purús.† They made the examination, and returned *viâ* the rio Mishahua.‡ He then verified their report personally by ascending the last-named river and its Serjali branch to its source, where by a short and easy portage he reached a small stream, navigable by canoes, which he believed flowed into the Purús. He only learned his error on a second voyage, which he made at the end of 1894, when, taking the same route, he ultimately found himself in the great river "Madre de Dios," the name of which he learned after reaching the *barraca* of "El Carmen," situated on the left bank in the middle of its valley. Realizing the importance of his voyage, he retraced his way and arrived at Iquitos, where he bought the steam-launch *Contamana* (of 3 tons

* The name suggests Irish ancestry—Fitz Gerald? ultimately softened into Fits-Carrald and then to Fiscarrald, which he was called in Spanish.

† *Geographical Journal*, vol. vii. p. 189.

‡ Before Fitz-Carrald opened the route which bears his name, a neighbouring portage, the Camisea-Serjali-Columpiani, was in use; but the difficulties incident to the navigation of the Camisea caused this to be abandoned. Some months previously to Fitz-Carrald's first voyage, a poor Peruvian rubber-collector, named Lache, had preceded him, had ascended the Mishahua and Serjali, crossed the portage, and descended the Manu and Mayu-tata to the town of Carmen; but no one then gave any importance to his perilous voyage.


Changes in the boundary line
between
BOLIVIA AND BRAZIL
in the
PLATA VALLEY
according to the treaty of
Nov 17th 1903
Scale of Miles
10 0 10 20 30
Nat. Scale 1:1 500 000 or 23·67 miles = 1 inch.
Frontier according to the treaty of 1867
Modification of the Frontier by the treaty of 1903.
L. Uberaba
Canal Pedro 2°
Ilha
L. Gahiba
Caracará
R. S. Lourenço
Uacurisal
Mt Carácará
Pedro do Amolar
Fuca Rozas
L. Mandiore
Durados
Firmiano
Barras
Bom Jesus
José Dias
Sucuri
Castello
Tuyuyu
Paraguay mirim
L. de Cáceres
Landario
Corumba
Urucum
S. Domingos
Campos do Jacadigo
Pirapitinga
Colony
Albuquerque
R. Jaquary
R. Miranda
M. Meavel
M. do Puca
M. do Conselho
B. da Fructa do Pato
Coimbra
Bahia Negra
BOLIVIA
BRAZIL
PARAGUAY
RIO
18°
19°
20°
57°
58°

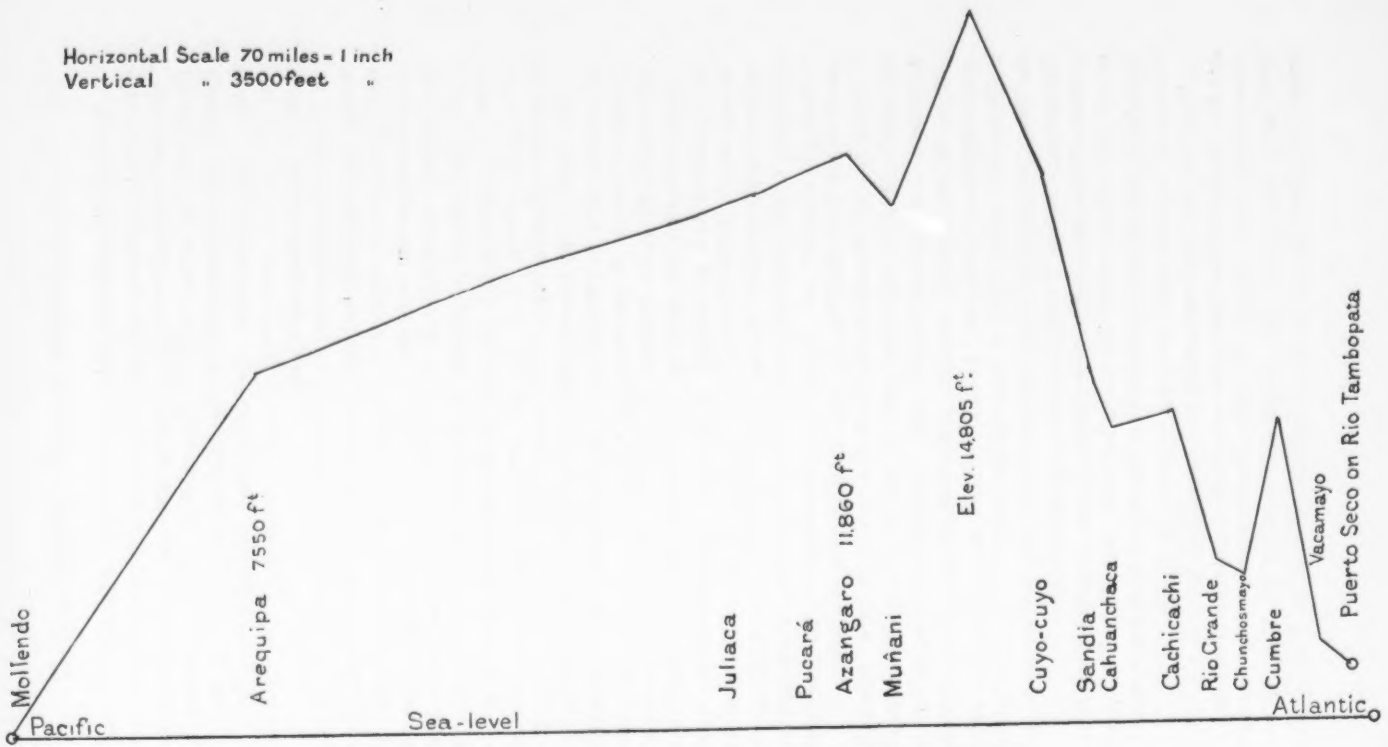
burden) and eight canoes, which he loaded with 25 tons of merchandise. He then reascended the Ucayali, crossed the portage, and, a few days later, appeared with his little flotilla among the settlements of the lower Mayu-tata, after fighting his way past the Guarayos savages, who lined the river-banks, and who probably were descendants of the same tribes that opposed the march of the great army which the Inga Yupanqui lost in his attempt to conquer their country and the Mojos. The voyage of Fitz-Carrald seemed to simplify the question of transportation, and to hold out the hope to Perú that its Amazon port, Iquitos, might become not only the centre of trade for the south-eastern part of her own territory, but the *entrepôt* for northern Bolivia. Subsequently a considerable trade was developed by the new route, and it grew in importance as the dispute over the Acre territory became more acute.

The reports of the "Junta de vias Fluviales" refer to four expeditions * which were organized by it in 1901, to study the "Madre de Dios" † river system. The first, under Colonel Ernesto La Combe, was sent to explore the several portages of the "Fitz-Carrald isthmus." The Ucayali had already been surveyed by Admiral Tucker, Wertheman, and others, so that La Combe's labours really commenced at the Mishahua branch of the Urubamba, which was found to be in lat. 11° 10′ S. and long. 74° 27′ W. from Paris. Here one of the steam-launches had to be sent back to Iquitos, as it drew too much water; the other had been wrecked in the Ucayali. The Mishahua and its Serjali branch were then ascended by canoes, the divide was crossed, the Caspajali tributary of the river Manu was descended for eleven hours until the Manu was reached, which in turn flows into the "Madre de Dios," although "some people believe that the true 'Madre de Dios' is the Pilcopata." ‡ Continuing down-stream, La Combe passed the mouth of the Inambari and arrived at that of the Tambopata. Ascending the latter, he returned to Lima by the way of the ancient town of Sandia, in Carabaya. His route across the water-divide between the Ucayali and Manu was new, easier, and had less broken ground than the one followed by Fitz-Carrald.

* Our President, in the *Geographical Journal* of December last, has already drawn attention to three of these.

† It is regrettable that the Spanish-Americans, as well as many other explorers, seem to have a mania for changing the names of rivers and localities. It ultimately gets the geography of a region into a perfect tangle. If they would only preserve the beautiful Indian names which existed at the time of the conquest, it would be a boon and a joy, not only to research and history, but to the "saints." As an example, why not adhere to Mayu-tata, instead of changing it to "Madre de Dios" because a wooden image fell overboard about fifty years ago?

‡ The Pilcopata is of great historic importance. It descends from the mountains of Paucartambo, and among its numerous western branches are the Cosñipata, Querus, Tono, and Piñipiñi, the banks of which were often visited in Ingarial, as well as in Spanish Colonial times; while, since the independence of Perú, many explorers have crossed the mountains from Cuzco to gaze upon what were supposed to be the head-waters of the Purús, but which Juan Alvarez Maldonado, as early as 1567, clearly demonstrated to be the great south-western sources of the river Madeira.



CROSS SECTION OF THE ANDES ON THE ROUTE TAKEN BY VILLALTA, ACCORDING TO BAROMETRIC OBSERVATIONS BY STIGLICH.

The extensive and interesting report of the engineer to the expedition, Juan M. Torres, says that the elevation of the junction of the Mishahua with the Urubamba is 795 feet above sea-level. The former, for 137 miles up to the Serjali, can be ascended in the dry season by craft drawing 3 feet of water. It is free from rapids, but full of trees and snags. The Serjali, which is 82 miles long, and only from 50 to 150 feet wide, is in no better condition, and presents many rocky and other obstacles even to canoe navigation.

The Portage.—The rise of the *divortium aquarum* between the river port on the west (1090 feet elevation) and that at the Cashpajali (1155 feet) on the eastern slope is 417 feet over broken, swampy ground, the distance between the two canoe landings now in use being $7\frac{1}{3}$ miles in a straight line; but the actual road is longer, owing to necessary deviations. The portage terminates at the Cashpajali, 22 miles above its mouth, at a point where the river is 200 feet wide. For the first 13 miles up, it is navigable all the year round for craft drawing 18 inches of water, but its remaining 9 miles present many obstacles to navigation.

The Manu, at the junction with the Cashpajali, is 1070 feet elevation. Its average width is 300 feet, with a depth of 8 feet and a current of $1\frac{1}{4}$ mile an hour. Its general direction is south-east for a distance of 158 miles, as far as the Pilcopata river, where, according to the report, it continues under the name of the "Madre de Dios," with a flow of 22,000 cubic metres per minute. Here its elevation is 718 feet above the sea, and its width about 500 feet. During the above course of 158 miles the Manu receives 135 large and small affluents. Although the inclination of its bed is not great, the obstacles to free navigation are exceedingly abundant, and consist of enormous trees and masses of tree-trunks which have filled the river during the period of freshets.

From the time it receives the Manu, the "Madre de Dios" carries its immense volume of waters 485 miles to the Beni over the extremely easy slope of a vast and fertile plain. Its banks are low, its bottom pebbly. A greater part of its course is filled with large and small islands, some sixty-three in number. Its width varies from 800 feet to about a mile, but the average may be taken as 1500 feet. Below the mouth of the Tambopata the flow is estimated at 191,250 cubic metres per minute. The average current of the entire river is $2\frac{1}{2}$ miles an hour.

Señer Torres is confident that the Mayu-tata, from the Manu to the mouth of the Heath, which is a few miles below that of the Tambopata, is navigable the entire year for steamers drawing 40 inches of water, the obstacles of trees and snags not being of great importance.

There are two important rapids and one cataract between the Heath and the junction of the Mayu-tata and Beni, a distance of about 300 miles which is not covered by Señor Torres' report. The first is a little below the mouth of the Heath, and is called the Vasquez; the second is at Camacho, a point about halfway between the Vasquez and

the mouth of the Mayu-tata. Each of these *cachuelas* has a fall of about 2 feet in a distance of 600, the water flowing over a broken rocky bottom, making navigation impracticable during the dry season. The great cataract of Esperanza, near the mouth of the river,* is insurmountable at all seasons of the year. It has a fall of 12 feet in a distance of about 150. The roar of the flood which pours over it can be heard for several miles.

The Mayu-tata receives three principal tributaries from the south—the Tambopata, Inambari, and Pilcopata. The exploration of the first of these was entrusted to Don Juan S. Villalta, assisted by Don German Stiglich (an accomplished Peruvian naval officer), Don Fernando Carbajal (engineer), and Don Aurilio Rencon. They acquitted themselves with honour, tact, and persistence, as did the La Combe expedition, for the latter also reached the Tambopata, and ascended and mapped it as far up as its Vacamayo affluent, just above Puerto Markham.

Villalta crossed the Andes from Mollendo to Sandia by the way of Puno, Azangaro (which is an ancient Indian town north of Lake Titicaca), and a pass of the inland cordillera, 15,000 feet above sea-level. The descent of the eastern slope of the mountains was abrupt and dangerous until near Sandia, which is 7000 feet elevation. It is one of the routes for rubber traffic by Indian carriers.† From Sandia, where gold is washed from the streets, he marched 54 miles in five days by a profanity-inspiring, mountainous, and swampy mule-track to the Huarihuari affluent of the Inambari, reaching a little settlement called Chunchosmayo. The road was opened in colonial times to serve coca, coffee, and tobacco farms.

From Chunchosmayo to Puerto Seco, on the Tambopata at the mouth of the Vacamayo, there is a footpath 77 miles long, which is replete with miseries. It traverses a forested, broken, and mountainous region, the summit height of which at the pass is 5180 feet above the sea. Ascending the Tambopata from Puerto Seco, the head of canoe navigation was found to be at lat. 13° 44′. Puerto Markham is at the mouth of the river Távara, 24 miles below Puerto Seco; and thence to the mouth of the Tambopata, on the right bank of which the Peruvians have now founded a settlement called Maldonado, 836 feet elevation above the sea, the distance is about 208 miles through a level country.‡ One may best

* The Beni is really a branch of the Mayu-tata, and the latter joins the Mamoré to form the river Madeira.

† See section of the Andes.

‡ With expressions of surprise, but with much insistence as to their accuracy, Señor Torres gives elevations on the Tambopata, commencing at 292 feet at its mouth, and ascending with considerable regularity to 850 feet, to a point 150 miles up-stream. His instruments must have failed him, as they often do when taken to high altitudes and then to low ones. The junction of the river Beni with the Mamoré is 446 feet above sea-level, and the waters of the Tambopata descend to this point. This throws a doubt

judge of the navigability of the river by reading the report in conjunction with the one, which is also very intelligently written, by the naval officer, José Maria Olivera, who accompanied the La Combe expedition. Together they indicate that the Tambopata offers every form of obstruction—sandbanks, reefs, boulders, rapids, masses of timber, trees, and snags—and that it can only be ascended with safety some 20 or 30 miles by vessels drawing 4 feet of water.

It is important to note that one of the reefs in the middle course of the river is composed of *piedra canga*. This is the same ferruginous conglomerate common to extensive districts of Brazil, including some of the rapids of the Madeira.

Stiglich, after reaching the Mayu-tata, ascended to the Paucartambo.*

The "Junta de vias Fluviales" also caused a survey to be made of the river Inambari by the engineer César A. Ciprani, whose report is of great value. He reached this important stream by Mollendo, Arequipa, and Macusani, crossing the Andes by a pass nearly 15,000 feet elevation. From the last-named place he went to Ollachea, and thence to Llinquipata, near the source of the San Gaban, an upper tributary of the Inambari; and, following the left bank of the torrential San Gaban, embarked his party in a canoe and on rafts near its mouth, and was wrecked almost immediately. The savages told him that if he descended the Inambari, "Machiganga estoja amico ijiatana" (the vultures will eat out the eyes of our friends). But he succeeded in his exploration, although wrecked several times among the rapids and whirlpools of this violent river, which he pronounces navigable by steam up to the mouth of the Marcapata, which flows in from the west about 60 miles' distance from the confluence of the Inambari with the Mayu-tata.

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upon all the elevations given in his report. There are also to be mentioned several discrepancies in the general maps of the two expeditions, especially notable in the location of the mouth of the Tambopata. Stiglich gives this as about 8 miles *east* of long. 72° W. from Paris, and Torres about the same distance *west* of the same meridian; but chronometers get rude treatment in crossing the Andes, and it is a wonder at times that they are of any service afterwards. They could be better cared for by ascending the rivers. Stiglich confirms this.

* The Paucartambo is one of the historic streams of the Inga empire. It flows northward near Cuzco, and has always been considered as one of the upper sources of the Urubamba; but President Pando's map makes it the main branch of the Mayu-tata. Torres says that its probable outlet is the Pinguieni, which enters the Manu about 20 miles above the mouth of the Pilcopata, or Condeja; while Stiglich, after ascending the latter for some distance, says that it is the continuation of the Paucartambo. But since these opinions were given, the Geographical Society of Lima has received a report from a Dominican missionary, Padre Zubieta, that he has recently descended the gorge of this famous river, and, following its course, found himself at the mouth of the Yavero affluent of the Urubamba. It would be a great boon to geography and to the history of that interesting region if Perú would have the Paucartambo properly explored.

Our explorer found the river-banks rich in auriferous gravel, which he estimated at "many millions of tons," containing "from 3 to 4 *soles* per cubic metre, but sometimes less than one sol."

Stiglich says that when the Inambari is in flood, it is almost impossible to ascend it in a canoe. It is then 40 feet deep at its mouth, and 1300 feet wide, but in the dry season it is but 13 feet deep. "It has no comparison with the majestic Tambopata," at the junction with which the Mayu-tata, in flood, is 78 feet deep.

To judge of the value of what we may call the Fitz-Carrald trade-route, a word should be said of the Ucayali. In 1867, a Peruvian Government steamer, the *Napo*, forced her way up its impetuous currents to the Tambo, and thence 35 miles up the Urubamba to a point 200 miles north of Cuzco. Bosquet in 1806, and Castlenau in 1846, say that this latter stretch is useless for navigation.

Señor Torres gives the length of the Alto Ucayali at 186 miles, counting from the mouth of the Pachitea to the junction of the Tambo and Urubamba. Its width varies from 1300 to about 4000 feet, due to the great number of islands. The current runs from 3 to 4 miles an hour, and a narrow channel, having a width of from 60 to 150 feet, can always be found with a minimum depth of 5 feet. There are five bad passes, sometimes due to the accumulation of trees and rafts of timber, and at others to enormous rocks which have fallen from the mountains and spread over the river-bed, occasionally causing huge whirlpools. "No greater difficulties present themselves to navigation by 10-knot steamers drawing 4 feet of water. These *data* are the result of actual examination, and their truth cannot be contested."

The river Urubamba, up to its junction with the Mishahua, 74 miles, is from 200 to 500 feet wide. Its bed is of shingle lying on rock. The greater part of the river runs through a plain, and is sometimes divided into several arms; but among these there is always a channel to be found, from 30 to 40 inches deep, with an average current of 4 to 5 miles an hour. The river-bed is full of trees, snags, and boulders, which are important obstacles during a greater part of the year. The waters have undermined the banks and broken down enormous masses of rock, against which the drift trees and gravel have accumulated, causing whirlpools up-stream and rapids further down. The report mentions six "principal" bad passes. "All, however, have a deep and easy channel. The navigation of the Urubamba at all seasons can be successfully carried on in craft of 10-knot speed and 18 inches draft. Cleaning the river of its obstructions and dredging the shallows a little, it can be navigated, under magnificent conditions, by craft of 3 feet draft of water," and further adds that "it is certain, evident, incontestable, that the rivers Urubamba and Alto Ucayali can be navigated the entire year without any danger whatever." Señor Torres then gives a long list of steamers which have been engaged in trade on

the Urubamba as far up as the Mishahua, and cites the *Union*, of 65 tons burden, 8-knot speed, and 3 feet draft, as having made ten round voyages heavily loaded, in their trade with the Mayu-tata valley.

One asks, what insurance would be charged at Lloyd's for vessels and cargo navigating the Urubamba under the conditions indicated?

Let us follow a shipment of goods from the mouth of the Amazon to the commercial centre of the Mayu-tata (Madre de Dios) valley, *viâ* Iquitos—

	Statute miles.
Para to Iquitos	2300
To mouth of Ucayali	62
Bajo Ucayali to junction with Pachatea	744
Alto Ucayali-Pachatea to Tambo and Urubamba junction ...	186
Urubamba to mouth of Mishahua	74
Mishahua river to portage	141
River Serjali	29
Portage	7
River Cashpajali	22
River Manu	158
Mayu-tata, or Madre de Dios, to mouth of river Heath	186
From Heath to Carmen, say	120
Total	4029

Of this distance, 1000 miles at least are described as being replete with obstacles to navigation, while 400 miles of the upper rivers so abound in obstructions that only the enormous value of india-rubber (£400 to £500 per ton) could induce the carrying on of commerce by such a costly and perilous route. But when trade seeks this channel, what obstacles must it encounter by other routes to the valley of the upper Madeira river? *

To obtain access to this garden of South America has remained an unsolved problem for several centuries. Elsewhere the writer has discussed it *in extenso*,† be it by crossing the Andes from the Pacific coast, or by the river Paraguay, or by the Amazon route; and it is his opinion that only by the latter can a commercial avenue be opened which will abundantly serve all the requirements of trade.

Reverting to the Acre, the "Treaty of Petropolis" makes a radical change in the Amazon boundary-line between Brazil and Bolivia.‡ It

* The cost of transporting goods at present past the falls of the Madeira is £80 per ton. The traffic is carried on entirely by canoes of from one to two tons cargo capacity. Until lately the charge was much higher.

† See 'The Route to Bolivia *viâ* the River Amazon: a Report to the Governments of Bolivia and Brazil,' 1877; "South America: an outline of its Physical Geography," *Geographical Journal*, April, 1901; "Northern Bolivia, etc.," *ibid.*, August, 1901; "Bolivia by the Rio de la Plata Route," *ibid.*, January, 1902; "Interoceanic Communication on the Western Continent," *ibid.*, March, 1902.

‡ The treaty gives it as follows (see map)—

Art I. § 5. From the confluence of the Beni and the Mamoré the frontier will descend by the river Madeira to the mouth of the Abuná, its affluent of the left

transfers to the former the Acre territory and a large area of country to the south of it—a total of 73,720 square miles; but Bolivia acquires a small but valuable triangular-shaped district of 886 square miles between the Madeira and Abuná rivers; and, on the western margin of the river Paraguay, four small pieces of land aggregating 335 square miles, in detail as follows; at the Bahia Negra, 279; at the Bahia Caceres, $44\frac{8}{10}$; at the Mandioré, $7\frac{9}{100}$; and at the Gaiba, $3\frac{2}{10}$ square miles. Article I. of the treaty sets forth the boundaries of these four fragments, which Bolivia hopes to utilize as ports for her south-eastern possessions (see map).

To compensate Bolivia for the greater area of territory ceded by it, Brazil is to pay £2,000,000, which Bolivia accepts "with the intention of applying, principally, to the construction of railways and other works tending to better communications and to develop commerce between the two countries."

Any disagreement which may arise in the demarcation of the new boundary-lines, and which the two Governments cannot adjust, is to be submitted to the *Royal Geographical Society of London* for arbitration.

There is to be perfect liberty of land transit and fluvial navigation for the two nations.

Art. VI.—"For purposes of exportation and importation of goods in transit, Bolivia may maintain customs agents alongside the Brazilian custom-houses of Pará, Manaos, and Corumbá, and at the other customs points which Brazil may establish upon the Madeira and the Mamoré, or other localities of the common frontier, and reciprocally Brazil may

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margin, and will ascend the Abuná to lat. 10° 20′. From there it will follow the parallel 10° 20′ towards the west as far as the river Rapirran, and will ascend this as far as its principal source.

§ 6. From the principal source of the Rapirran it will follow along the parallel of the source until to the west it strikes the river Aquiry, and will ascend by this to its origin, from which it will continue on as far as the streamlet of Bahia by the most broken ground or by a straight line, as may appear most convenient to the demarcation commission of both countries.

§ 7. From the source of the streamlet of Bahia, descending by this, it will run as far as its outlet on the right bank of the river Acre or Aquiry, and will ascend this to its source, providing this be not west of long. 69° west of Greenwich.

(*a*) In the supposititious case, that is, if the source of the Acre should be in long. not so far west as that indicated, the frontier will follow by the meridian of the source as far as the parallel of 11°, and afterwards to the west by this parallel as far as the frontier with Perú.

(*b*) If the river Acre, as appears to be the case, cuts the longitude of 69° west of Greenwich, and should run now to the north and now to the south of said parallel of 11°, more or less accompanying this, the main channel of the river will form the dividing line as far as its source, by the meridian of which it will continue as far as the parallel of 11°, and from there in a westerly direction, by the same parallel, to the frontier with Perú: but if to the west of the said longitude of 69° the Acre should run always to the south of parallel 11°, the frontier will run from this river by long. 69° to the point of intersection with this parallel 11°, and afterwards along it as far as the frontier with Perú."

maintain customs agents at the Bolivian custom-house of Villa-Bella or at any other customs point which Bolivia may establish on the common frontier."

Within a period of four years, Brazil is to build the *Madeira and Mamoré Railway*, with a branch to Villa-Bella in Bolivia, and both countries are to make use of it with the same privileges and tariffs. Brazil is to discuss directly with Perú the question of the western frontiers of the territory ceded by Bolivia.

This treaty is of the highest import to the whole of Amazonia. It is characterized by broad and far-reaching statesmanship, which is a credit to the Governments of both countries. The gain which Bolivia will reap from the construction of the Madeira and Mamoré railway alone is worth all of her territorial sacrifices, while the opening of such a grand trade avenue will give life and activity to the 533,000 square miles of dormant Matto-Grosso, a Brazilian state which possesses almost boundless agricultural, pastoral, and mineral resources.

Nations have maintained a tropical correspondence with Brazil for nearly a century regarding freedom of navigation and riparian rights on the Amazon and its tributaries, and much unwarrantable abuse has been showered on that country for its apparent exclusiveness. The problem was a difficult one for Brazil. In 1870 the writer had a long conversation on the subject with His Imperial Majesty Dom Pedro II., who argued that "to throw the Amazon open to all of the bordering states before concluding with them treaties of limits, and establishing regulations for the government of fluvial commerce and the proper policing of the vast river system, would heavily tax the exchequer of the empire without corresponding advantages." His Majesty further said, "By the Decree of December, 1866, we have opened the main river and several of its affluents, the latter to points just above their mouths. The Madeira, in which you are interested, you desire to have opened to San Antonio, its last fall; but it is now free only to Borba, a few miles up. The moment you show me that there is sufficient commerce to warrant it, Brazil will comply with your wish." Two years later, at the request of the writer, the desired decree was issued, and the main branch of the Amazon made free to navigation throughout.

By the "Treaty of Petropolis," the Republic confirms the policy of the Empire, and the Premier of Brazil, Baron Rio-Branco, shows himself to be a statesman of the first rank. The treaty goes far towards making the grand inland reservoir of the Amazon an international sea, to be used in common by all the republics which have rivers flowing into it. They are practically told that, by friendly agreement, they may, side by side with the Brazilian custom-houses, collect their own import dues and freely carry on their foreign trade in transit. This is a long step in advance, when compared with the policy which ruled in colonial days. It holds out the hand of good fellowship between the

descendants of Portuguese and Spaniards, and promises to break down many of the prejudices which they unhappily took with them to the New World.

A JOURNEY FROM PEKING TO TSITSIHAR.*

By CLAUD RUSSELL, M.A.

THE route followed by Mr. Hicks Beach and myself was roughly a north-easterly one from Peking to Tsitsihar. It was suggested by Lieut.-Colonel Wingate, in charge of the Intelligence Branch of the British Forces in North China, as likely to afford new ground. We were accompanied by a Chinese servant, a cook, and two pony-boys, who all worked well and gave no trouble. We reached our destination on our forty-ninth day from Peking, the distance covered being a little over 1000 miles.

The road from Peking to Jehol has been described by Sir Geo. Staunton in his record of the first English mission to China. It has not changed since Lord Macartney passed over it in his gilt coach 110 years ago. It only strikes one that the dilapidation and decay, which now mark so much of China, were not then such as to excite the comments of the traveller. Jehol itself has been many times visited since then. The "Versailles of China," as the Abbé Huc calls it, is a squalid and uninteresting town. It has ceased to be a royal residence in this generation, but as the seat of government of the northern "March" it retains its official importance. The wall of the imperial park is the most prominent feature of the town. No European has entered it since Lord Macartney was received by the Emperor Chien-lung, and the account of the author above mentioned is, as far as I know, the only foreign description we have of it. There appears to be no one prominent building, but a number of kiosks and pavilions are scattered over the park and on the slopes and summits of the hills enclosed in it. Such as are near enough to the wall for a view to be had of them are approaching a ruinous condition. There are streams and lakes in the park, and the grass is of a colour rare in Northern China. These, with the deer feeding under the trees, present a singularly charming aspect when seen from without on a hot day. No emperor has visited Jehol since Hsien-feng, the husband of the present empress dowager, died there on August 22, 1861. But though the family has been so long absent, their wardrobe awaits them. The annual airing took place while we were in Jehol. The high officials of the Government repaired to the palace and stood round for the space of three hours while the imperial silks and sables were exposed to

* Map, p. 704.

the sun. The temples of Jehol are in a sad state of decay. This is especially the case with the two lama monasteries. They retain nothing of the magnificence ascribed to them in Staunton's description. They are unique among buildings in China. Both are square, or rather cubic, blocks over 150 feet high. The variegated colours of the eleven stories are all but washed out. On the altars of the temples inside are priceless bronzes, porcelain, and cloisonné, all inches deep in dust. We noticed particularly some French eighteenth-century vases on which were depicted scenes from life in châteaux of the period, very unsuitable for altar decoration. Beyond that they were "foreign," the lamas knew nothing of their origin. These buildings are modelled on the residences of the Dalai Lama at Lhasa, and of his subordinate at Shigatse, and the former is likewise known in Jehol as "Potala." Those who have seen both say that it is a perfect counterpart, though on a smaller scale. The local explanation is that the emperor was anxious that the grand lama should feel at home while in attendance on the court during its annual three months' stay at Jehol. Taking into consideration the time occupied by a yearly journey to Lhasa and back, one is led to the conclusion that the time left him to attend to affairs in his own capital must have been very limited. However this may be, an inscription in the building dedicates it to the memory of three remarkable events which took place during its construction, namely, the desertion of the Kalmuk Tartars of Russia and their return to Chinese allegiance, the sixtieth birthday of the emperor, and the eightieth of his mother. When we read that these achievements were crowded into a space of two years, and consider that the reign of Chien-lung extended over sixty years, we cease to wonder that the period is reckoned glorious in Chinese history.

The local officials of Jehol, though most obliging, were not encouraging as to our being able to follow the route we wished. It lay across the Wei Chang, the hunting-ground of the emperors. We were assured that this was uncrossable; that it was in part an impenetrable jungle, in part a desert; that it was inhabited by tigers and bears; that it was at that moment the refuge of a brigand chief; and, finally, that our way would lead us through a distressed district in which it would be unwise to expose the population to the temptation of our stores. I may here say that, as far as our acquaintance with the Wei Ch'ang went, it is crossed by good cart-tracks, that the greater part of it is cultivated and inhabited, and that it contains nothing more dangerous than pheasants.

We had some difficulty in obtaining mules with which to continue our journey beyond Jehol. This was in part due to the impossibility of making known the time for which we might require them, or where we wished to go. The name Tsitsihar appears to be unknown to others than Europeans. The Mongol name is Bukwéi. The Chinese

official name being Hei-lung-chiang, I am at a loss to explain the derivation of "Tsitsihar." The five mules and a donkey we finally engaged constituted our transport for the next thirty-three days. The mule of China is an animal of great endurance. I believe the maximum load for a mule is reckoned in the army at 130 lbs. I had no means of reckoning what one of ours carried beyond that it took six men all their strength to hoist the pack on to its back. The saddle on which this rested cannot have weighed less than 20 lbs. With this load it would walk 30 miles a day. The latter part of the journey they did entirely on grass, a food to which they must have been wholly unaccustomed. These mules are not the magnificent animals which are to be seen in Peking. They are lean and scraggy, and stand little over 14 hands.

The stony valleys and empty watercourses which characterize the country between the Great Wall and Jehol are continued for another 80 miles beyond that place. We went through the town marked on maps as Po-ro-ho-tun, but locally known by its Chinese name of Huang-ku-t'un. It is a fair-sized place with a busy market, and lies in a small fertile valley surrounded by hills. The country population of this district is scanty, but apparently not over-poor. The ordinary grains are grown, and some rice, but the staple crop is the poppy. There is no hovel without its adjoining patch. The opium harvest was in process of being gathered. I noticed that the heads were sliced horizontally, and not as I have seen it done elsewhere. It would appear that this must be added to the number of little facts which are cited to illustrate the contradictoriness of the Chinese nature. The impression at leaving the cultivated country and entering the first wild valley of the imperial hunting-grounds is one of indescribable charm. Through it runs the I-sun Ho, a deep and rapid stream of clear water. The hills are low and well wooded, and the grass is long and full of flowers. The novelty of such surroundings to any one coming from the plain of Peking adds to its delights. Unfortunately, its does not last long. Maps and popular report had led us to believe that the Wei Chang (as such) extended north for a distance of 100 miles. We had not gone 10 before we came again upon signs of human habitation. Why this apparent belt of wild country has been preserved, I cannot say, unless it be on the principle which is known to Europeans in China as "look see." The encroachments on the imperial preserves are evidently in this part of recent date. The inhabitants had all the appearances of pioneers; their cultivation is patchy, and they are living in log-huts, owning nothing apparently but a plough and a yoke of oxen. There are no women. I believe this work is in process throughout the Wei Chang, of which, no doubt, there will soon be nothing left to tell its former character. In the more northern portions which we crossed, the work is long accomplished.

There there are small villages and well-built farmhouses which cannot date from less than a hundred years back. Of special Government supervision over this territory or of imperial gamekeepers, of which other travellers have spoken, we saw or heard nothing. Huc, writing in 1844, says that it was then twenty-seven years since the emperor had hunted there. Venery has ceased to appeal to the decadent character of the last Manchu emperors, and the forest has lost its *raison d'être*. Of game, other than birds, we saw nothing beyond a herd of Huang-yang (*Antilope gutturosa*), and an animal the Chinese name of which is exactly represented by the English sound "lady." This, though not the Chinese for a wolf, appears, to judge by the animal we saw, to be a local name for it.

On many maps the Khingan mountains may be seen marked as a well-defined chain running north and south. The country through which we travelled was, from within 60 miles of Peking and 30 of Tsitsihar, a continuous mountainous tableland, varying between 2000 and 3000 and even 6000 feet; nor was any predominating range at any time visible. As to the existence of Mount Petcha, which one may see set down as a peak among the Khingans, with a height of 10,000 feet ascribed to it, we were led to entertain doubts. The authorities for its presence appear to be the Jesuit Fathers Verbiest and Gerbillon, who travelled extensively in this country at the end of the seventeenth century. The latter, on Chinese authority, gives it a height of 9 *li* (say 15,000 feet*), but describes it, not as a peak, but as "un amas de plusieures montagnes." He says that ice is to be found on it throughout the year, and hazards the suggestion that this is attributable to its great altitude. I am told that Dr. Bushell, in a record of a journey made in 1872, and which appeared in the *Journal*† of this Society, but which I have not seen, states that even the name of the mountain is unknown; and this was likewise the experience of the Russian traveller, Fritsche. Ours was similar, until a passer-by of exceptional intelligence suggested that it was perhaps "Paich'a" we were seeking. Inquiries after this name continued to meet with a response, but we could never connect it with mountains. It appeared to be rather applicable to a district, and two peasants, at whose farms we put up, claimed it as the name of their homesteads. As against this, Dr. Franke, in his learned work on the Jehol prefecture, states that when travelling in 1896 he located the mountains in question, known exactly by the name transliterated by the fathers, and that he made their greatest altitude roughly 10,000 feet. He admits their invisibility, which he accounts for geologically, and which is certainly remarkable, for in what must be the near neighbour-

* Or it is possible this height was computed on the Chinese system, *i.e.* that it was a walk of 9 *li* (3 miles) from the foot to the summit of the mountain. Reckoned by our methods, this might reduce it to something very moderate.

† *Journal*, vol. xliv., 1874, p. 73.

hood of the district indicated by him the road goes over a pass of 6100 feet; here, among the great extent of hills visible, there was certainly no point with an appearance of being more than 500 feet higher than we were. Dr. Franke identifies it with the range and plateau described by Huc as the "Sain Oula." But the Abbé's description of this country must strike those who have visited it as somewhat imaginative, even if he had not, a few pages previously, shaken his reader's confidence by recording a fall of hailstones weighing 12 lbs. each.*

On our seventh day after entering the Wei Ch'ang, following the course of Ta-chi-ku, a small stream, we crossed what we took to be the Shara Muren. There was no one near from whom to ascertain its local name. The track led from here through a sandy valley, with very scant vegetation in about 10 miles, to Ch'ing-p'eng. It is a busy Chinese town of mud houses, with perhaps 5000 inhabitants, prettily situated among the hills at a confluence of streams. It was visited, I believe, by Dr. Donaldson Smith in 1897, and, from the curiosity excited by our arrival, I should think by no European since then.† A comparison of the inhabitants with the unobtrusive peasants we had lately been among exemplified the bad effect of town life on manners, especially in the case of little boys. Provisions were obtainable here, and we laid in a store of flour, rice, and potatoes. There is no market between this and Tsitsihar. Here, also, through an obliging mandarin, we secured the services of a Chinese-speaking Mongol. His ignorance of the country prevented his being much use as a guide, especially as his conception of guiding was to ride 10 miles ahead of the caravan, on the pretext of preparing the natives for our arrival, but really because he thus shortened his day's march by some weary hours. He was indispensable, however, as an interpreter, and his introduction of us to his compatriots always produced a warm welcome. He had a useful capacity for borrowing horses, and he never failed to secure two or three. These horses would often make a stage of several days with us, and, on arrival at a settlement, others would take their place. By what means they found their way back to their owners I could never make out, but the arrangement seemed to be an accepted custom of the country.

For nearly two days beyond Ching-peng there is no change in the character of the country. There is the same tedious succession of fields and valleys. With the exception of the poppy-crop, the cultivation is

* Since writing the above, I have seen a reference to Mount Pecha in a memorandum of a journey by Mollendorf in this district in the Society's *Journal* of February 1881. He says the Chinese inhabitants speak of a mountain called "Baitcha," and that reference to it may be found in Chinese literature. He does not appear to have visited it, and gives its situation and height (9000 to 10,000 feet) on Chinese authority. The mystery of this veritable "Mont Perdu" seems still to call for elucidation.

† The boots at the inn told me, with much laughter, that the town was also known as "Ch'ingli-ch'ing," or "P'engli-p'eng." No doubt a local joke of great antiquity, which I forbear to translate.

very poor. New farms and houses in course of building mark the recent advent of the Chinese. Their present limit is about 35 miles north of Ching-peng, at the village of Lu-chia-ying-tsu. I note the name, in the hope that subsequent travellers may mark the rate of advance. The change is clearly marked. There is no half-and-half country. As one leaves the village, cultivation ceases, and the grass country begins. The Chinese are showing the capacity, of which they have given evidence in many parts of the world, for ousting the original inhabitants. The present extent of Chinese colonization outside the Great Wall is probably a growth of not more than the last 100 years. There seems no reason why it should not continue in the direction it is following (given a growing population) until these settlers join hands with their countrymen of Northern Manchuria, from whom they are undistinguishable in all apparent characteristics. The grass country is not one that at first sight seems suited to colonization. It is destitute of wood, and water is often scarce. It must be remembered, however, that the Chinese peasant is not dependent on the former. He grows his fuel with his crops, and with millet stalks and straw he has a sufficiency for his winter firing. The "argol" fuel of the present pastoral inhabitants would be no longer procurable with the disappearance of their herds. As regards water, I believe that, though one may often do a day's journey without seeing any, it could in many places be found by digging. In any case, there are now many miles of broad well-watered valley entirely uninhabited.

There are some hot springs by the road about 20 miles north of Ching-peng. The place is named Tang-shan. The arrangements for those anxious to benefit by their healing properties are very primitive. A row of twenty or thirty wooden boxes, the size of an ordinary packing case, are ranged beside the road. In these sit bathers of every age and both sexes, with their heads protruding. Attendants with buckets continuously refill the boxes from the springs. For less luxurious bathers, there is accommodation in a pool which has been dug out close by. In this they squat, scooping up the water and pouring it over their heads with brass basins. It is curious to reflect that establishments like Homburg and Aix-les-bains have had their origin in such beginnings.

The maps of this country which I have seen are of little use to the traveller. The names on them appear to be the product of fancy. I believe the most recent, and certainly the most detailed, is one published in 1900 by the Russian Department of Finance. I failed to identify a single name on this map north of Ching-peng. Making every allowance for changes consequent on Russian transliteration and re-transliteration into English, it is difficult to conceive from what source they were derived, unless it is that they mark Mongol camps, noted by some traveller, which now no longer exist. We were at first, not unnaturally, led to believe that they indicated the sites of populous towns, and having fixed on one which appeared to be on our line of route, we

ordered our guide to take us there. Anxious for his reputation, he acquiesced, and, after leading us in varying directions for two days, finally halted in a barren valley, and announced that this was undoubtedly the spot we were seeking. After this, until we were within a few days of Tsitsihar, when it became possible to go by native directions, we took our course from the compass. In all matters connected with the road, distances, direction, the presence of inhabitants or water, etc., we always found the natives, I believe with the best intentions, the most consummate liars. About 50 miles off Ching-peng the Russian map above mentioned marks "Tomb of the Chinese Empress." We found a tomb approximately on the spot, but it is difficult to see how this description became attached to it. It is a seven-storied pagoda, and the only building of any pretensions in all the country we passed through. A Peking Chinese, a Government guardian in charge of it, told us it was 2000 years old, and the resting-place of a Mongol lama, and that it was called the "White Tower." He said that the right road to it from Peking was through Lama Miao, and that we were assuredly the first Europeans who had been there. As, however, I see an unmistakable photograph of the tower (but without any letterpress) in Dr. Franke's book, before mentioned, I fear we cannot claim this distinction. The designs on its face are un-Chinese in character, and one especially depicts a very Assyrian bull (or lion). Round the base of the tower attendant lamas walk unceasingly, carrying each, on a wooden pack upon his back, a load of books. I have never seen this form of devotion elsewhere. The altar decoration of the shrine within is a silver teapot with three peacock's feathers in it. Lamaseries, of which we came across four or five, are the only buildings in this country. They are wretched conglomerations of mud houses surrounding three sides of a temple. Contrary to what is usually reported of them, we always found the lamas civil and friendly. The settlements of the lay inhabitants are the same "yourts" as those of the Western Mongols, *i.e.* tent-shaped huts of wattle and felt. It is curious that men who are so rich in some respects—in cattle and sheep or ponies—should be satisfied to live in such discomfort. Their personal dirt is beyond description. They are a cheerful people, with a great idea of their obligations towards the stranger, and, at the same time, without any great curiosity in him. They have none of the demeanour, so offensive in the Chinese, which the Rev. A. Smith describes as "amused interest combined with depreciation." If they allow themselves to stare, it is with honest admiration for all one's belongings. Unlike the Chinese, they have none of their preconceived ideas of the unpleasant peculiarities of foreigners, which make us so interesting to them. The Chinese regard them as very poor creatures, and adopt towards them the manners of a dominant race; nor did I ever see it resented. Their most striking peculiarity is their indifference to money, for which they seem literally to have no use.

They place all they have at the disposal of the stranger, but no payment is expected. It is possible to live well on the food of the country, as far as it goes. The milk and cream are of the best. On arrival in camp, a sheep is killed for the stranger's benefit.* It is worth going to Mongolia to eat mutton, which is unlike any other in my experience. No traveller who has written on the country fails to mention it. Missionaries, Protestant and Catholic, alike refer to its succulence. There is also a very excellent product of milk to be had, peculiar to the country. It is made in large round flexible flaps, about a quarter of an inch thick, with a hard coating top and bottom, and a substance resembling Devonshire cream in between. I was unable to find out by what process it is made. Colonel Younghusband mentions it, and refers to the value its portability gives it for the traveller. Though there is much cattle in the country, beef is never seen. Oxen are kept and driven to the Chinese markets in the winter, where they are exchanged for grain and such small requirements as their owners have. It is said that drunkenness is a national failing of the Mongol. I have never seen soberer people than those we met. Only on one occasion, when a jar of Chinese wine was produced as a matter of ceremony, were we offered alcohol in any form, and we were never asked for it. Tea, with an admixture of salt and mutton grease, is the common beverage. It is not recommendable. Snuff-taking is universal, and the offer of the snuff-bottle is the general method of greeting. These Mongols appear to seclude their women in some measure, at least from strangers, and our arrival was usually the signal for a hasty departure of the ladies of the family for the tents of their next neighbours. Children are scarce, and the impression left is one of a diminishing population.

A Mongol prince has his seat at Chastuchi. The situation is a very pretty one, in a broad grassy valley which, unlike any other, is well planted with trees. An embattled wall of mud surrounds the settlement, and encloses a considerable space. Outside the gates are the great poles emblematic of official China. The inside is further divided by walls, and contains many separate houses, some in Mongol and some in Chinese style. We were most hospitably received, and assigned a clean and roomy "yurt," comfortably fitted with Chinese furniture. The prince's visiting-card, written in parallel columns of Mongol and Chinese, describes him as Chieftain of the Horchin Tribe of the Cherim League.† It also states him to be the holder of an appointment

* Their method of killing sheep is curious and unpleasant. The animal is thrown on its back, when the butcher makes an incision in its belly, into which he thrusts his hand, where he presumably severs an artery, as death ensues and the carcase is suffused with blood. He then takes a ladle and transfers the blood to a receptacle at his side. No drop is spilt.

† His attendants refused to tell us his personal name; nor would he, when asked, say it before them. I imagine it was only a form of deference, for which parallels exist with us, and not a case of taboo.

connected with one of the gates of the imperial palace in Peking, whither his duties call him once in three years. He is a man of unmistakable breeding, of the good-looking type, with a very white complexion. He wears Chinese official dress, with a button of the Prince of the Blood. He is treated with marked respect by his dependents, and the general air of the place left on one an impression of happy patriarchal life and simplicity. He knew no language but Mongol. He had plenty of conversation, and asked many questions about his guest's country, whether we lived in tents, and owned cattle like he, etc., and whether in our travels we had not visited Lhasa. Politics do not seem to trouble him, and he did not know whether or not Tsitsihar (distant five days) was still in the occupation of a foreign army, although he had heard of its being so. He was more interested in shooting, which he practises from pony-back, and uses a modern breech-loader. When we left, he supplied us with a cart and a mixed mule and pony team for our luggage, which very much expedited our progress, as we were able to dismiss our pack-mules. I would recommend travellers in this country to rely on cart transport. There is no reason why one should not drive anywhere in a comfortable victoria. It is crossed in every direction by well-marked tracks through the grass, and in some places, where these are well worn, there is all the hardness and appearance of a metalled road. We met no cart traffic, but to account for the condition of the roads, there must be a good deal at some period of the year. The country beyond Chastechu, following the valley of the Gadlin river, is fairly well wooded, and comparatively populous. Here one begins to see traces of settled habitations. Some houses, though retaining the tent form, are solidly built of mud, but one also sees them of Chinese type. There is some cultivation round the houses, and the inhabitants make hay, keep poultry and pigs, ride donkeys, and sometimes even walk, contrary to the Mongol habit of never stirring without a pony. As one approaches the Manchurian border, one finds Mongol farms and villages, of which the inhabitants, except as regards their language, are not distinguishable from Chinese. It is not easy to see why they should have come so strongly under Chinese influences, when the Mongols of the southern border, though, one would think, in closer contact with them, retain their national habits unaffected.

The rivers we crossed contain little water. They follow courses of extraordinary tortuousness. The Gadlin and Yala Ho are of a fair size, and might be navigated by boat, but the Shaling Golla was the only one we crossed which was not fordable on horseback.* Small streams and torrents, such as are usually associated with a hilly country, there are practically none.

* The owner of the dug-out boat, who ferried us across, is remembered by me as the only Mongol we met who asked for money.

The summer climate is very temperate. The minimum night temperature varies between 40° and 50°. It fell to freezing-point on one occasion (end of August), the altitude being 2100 feet. Although the season was that known as "rainy" in North China, rain did not fall on more than half a dozen days, and then in moderation.

The country cannot be called rich in animal life. Snipes are plentiful along the rivers, and so are plovers, and during the latter part of the time we found an abundance of quails. There is also a large grey goose, of which we were unable to obtain a specimen, and a smaller one with a terra-cotta back and parti-coloured black-and-white wings, which I have been unable to identify. A crane (*Grus cinera*) is common in couples. There is no large bird of prey. Unfortunately, Mr. Hicks Beach's collection of birdskins, being left one night outside the tent, fell a victim to a marauding dog, which also disposed of about 20 lbs. of flour. We only once saw deer (or antelope)—three hinds—some distance off, but inquiries of the natives with regard to them always led to assurances that if we had only been there the day before, or would wait a little, we would be satisfied. Of smaller mammals, two hares were shot (*Lepus hispidus*, I think). They were about the size of a small English rabbit. The burrows of an animal, presumably of the marmot tribe, are very common, but their inhabitants appear to be nocturnal. There is no lack of insect life in the long grass, both in numbers and variety. The general absence of mosquitoes is a boon to the traveller. We only came across them once, and in curious circumstances. We had camped in the dark without water, and there was none, so far as I know, for 15 miles on either side of us. Shortly after sunrise mosquitoes made their appearance. They attacked, not in the usual tentative manner, but with the ferocity of angry bees, and only let go their victims when killed. The Mongols with us suffered equally with ourselves. They pursued us in clouds for about 10 miles, and then left as suddenly as they had appeared. Except for their apparent independence of water and diurnal habits, they had the characteristics of others of their sort.

There is perfect security in the country we passed through. It might have been thought, from accounts of the great bodies of brigand cavalry with which the Russians have had to deal in their pacification of Manchuria, that some remnants of these might have been pushed over the border and be pursuing their occupation in Mongolia. But we saw nothing of them, and heard no stories of anything of the sort.

It has been indicated that this country, from its winter climate and absence of fuel, offers no field for European colonization. Also, that it is not a "sportsman's paradise." I should like to add that, unlike most little-visited districts, I see no reason for believing it to be "rich in undiscovered minerals." Further, that it appears to offer no prospects

to railway enterprise. A line through it would hardly be described in the most sanguine prospectus as "tapping rich districts."

We struck the Manchurian railway at Fulardi, about 20 miles from Tsitsihar station. A vexatious corporal, in charge of a piquet by the Nonni river, made it clear to us that we had passed under the jurisdiction of another power. I may say that Western civilization, with its bayonets and jerry building, as seen at a Manchurian railway station, presents an unattractive aspect beside that of the free herdsmen we had been among. We returned to Peking from Tsitsihar by rail in five days.

Throughout the journey we met with the unfailing courtesy and consideration from all classes which is the experience of most travellers in China, and often in contrast to what may be met with in Europe among nations who lay claim to a higher civilization.

ON THE DIMENSIONS OF DEEP-SEA WAVES, AND THEIR RELATION TO METEOROLOGICAL AND GEOGRAPHICAL CONDITIONS.

By VAUGHAN CORNISH, D.Sc., F.G.S., F.C.S., F.R.G.S., M.J.S., Associate of the Owens College, Manchester.

PART I.

No really good method of measuring the height of waves from a ship on her course has yet been introduced into general use, but numerous rough measures of height have been made, based upon the principle that when a wave-crest, passing not far from the ship, just obscures the horizon, that crest has the same altitude as the observer's eye.

When an observer has made such estimates a daily practice he becomes fairly expert, and, according to the late Lieut. Paris, who was one of the most diligent of such observers, the estimate may be relied upon to 1 foot in 10.

The measurement of the distance from crest to crest of two following waves may be carried out with some approach to accuracy if the co-operation of two observers be secured (who can simultaneously note the position of two succeeding crests along the ship's side), or with the aid of a buoy towed at a known distance astern.

In addition to the measurements of height and length, those of the velocity of the wave, and the interval of time between the passage of two crests, may be considered as two of the "dimensions" which have to be measured. The velocity is determined with tolerable ease by two observers provided with suitable watches, whenever the course of the ship is nearly the same as that of the waves, whether the waves follow or meet the ship. The speed of the ship being known, this is added to, or subtracted from, the apparent, in order to obtain the true, speed of the waves. When the course of the ship makes a small

angle with the course of the waves, proper allowance can be made for this divergence, but, if the difference of direction be great, observations of velocity cease to be reliable.

The "period" of the waves is the interval of time which elapses between the arrival of two succeeding wave-crests at the same place. Of all the "dimensions" of waves this is the easiest to observe from the shore, but from on board ship the period between the arrival of two wave-crests is either greater or less than the true period, according as the ship travels with, or against, the waves. Here, again, the necessary allowance can be made if there be the two co-operating observers who have already determined the speed of the waves.

Thus, if suitable arrangements be made, the most important of which is that two persons should be simultaneously told off to the duty, fairly accurate measurements of the length, velocity, and period of the waves can be obtained, *if the sea be not too irregular*. The heights of some of the waves can also be determined, of those, namely, which rise to an elevation equal to that which the observer selects for his own position. The height of the smaller waves can often only be guessed at. The height of those which rise higher than the eye can be judged with some approach to precision.

Rough as these methods are, the number of waves encountered is so great that they would give us reliable averages if there were but one set of waves running at a time. This, however, is seldom, if ever, the case. In deep water far from land, where the speed of the waves is not limited by insufficient depth of water,* each series of waves travels at its own proper speed, depending upon the depth to which the agitation of the water extends.

The apparent confusion is often such that any attempt at correlated measurements seems almost hopeless. Sometimes the confusion is due to a crossing sea, in which waves from different directions pursue their independent courses. Two sets of waves of nearly equal dimensions, crossing at an angle of, say, from 45° to 90°, may parcel out the surface of the sea into a number of conical hillocks or domes, arranged in groups of four about an elliptical valley, and each of these domes will travel in a direction which is not that of either of the constituent waves, but diagonally. The observers who have measured waves systematically generally refrain from attempting measurements under these conditions, which are, however, very common.

There is another kind of irregular sea which is also quite normal

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* The velocities for shallowing water as calculated by Sir G. G. Stokes are as follows:—

Depth	∞	l	$\frac{l}{2}$	$\frac{l}{4}$	$\frac{l}{8}$
Velocity ...	1000	1000	996	933	429

l being the wave-length.

and characteristic, but in which continuous measurements of waves are very difficult. In this kind of sea there is no perceptible crossing of waves, and sometimes two or three long steep ridges may be seen following one another at equal intervals, but they are succeeded by a stretch of water whose surface is only slightly undulating, and in which the positions of crest and trough occur at intervals which are very difficult to determine. To this long "smooth" succeeds a piece of rough water, and so on.

It is hardly possible to suppose that in such a sea each *apparent* wave is a member of a single series of undulations, varying in its character from ridge to ridge. Such an arrangement would need some complicated mechanism to preserve it, as, for instance, a corrugated raft of the same shape drawn over the surface of the sea. These seas, however, preserve their character almost unchanged for a considerable time, even in absence of wind. One is compelled, therefore, to accept the view, that the apparent waves in such a sea are due to the superposition of two or more independent series of undulations travelling in the same direction, and *differing but little from one another in length* (Fig. 1).

The kind of sea which has been generally selected for wave measurement is neither the crossing sea, parcelled out in domes and basins, nor the irregular sea, parcelled out in smooths and roughs, but the fairly regular sea, in which well-defined ridges of water follow one another with sufficient regularity of height, wave-length, and direction for the observer to be able to keep continuous account of them as they pass.

These fairly regular seas, to which most of our systematic records refer, may be seen either during the continuance, or after the cessation, of the wind which has created the waves. I will deal first with the measurements of fairly regular seas, made when the waves appear to have attained their full dimensions under the action of the wind which still maintains them. We will take first the average size of the

FIG. 1.—COMBINATION OF WAVES OF 300 FEET AND 350 FEET LENGTH RESPECTIVELY. SCALE: HORIZONTAL, 1 IN. = 200 FEET; VERTICAL, 1 IN. = 100 FEET

apparent waves as recorded, because this will go far towards answering the question, "What is the size of the waves during a storm at sea?" The tables on pp. 641–643 give the average height of the waves during winds of different strength, from a great number of observations in the Atlantic, Pacific, Indian, and Southern oceans. The numbers are, first, from the record of the voyage of the *Astrolabe*, published by Admiral Desbois.* The number of observations made was several thousand. Secondly, from the observations of Lieut. Paris, which extended over two years, during which he measured about 4000 waves. His paper in the *Revue Maritime et Coloniale* for 1871† is still the best record we possess of an extensive series of wave measurements. Thirdly, extracted from the records of other French observers, collated by M. Ch. Antoine.‡ Fourthly, from observations of Captain Wilson-Barker, R.N.R., of H.M.S. *Worcester*.§

We may take the *average* height of all the waves running in "a gale" in open sea as about 20 feet. But, according to Lieut. Paris, the height of the individual waves was often found to vary in the proportion of one to two; it was only very rarely that the average height was seven or eight tenths of the greatest height. There is, in fact, even in a fairly regular sea, a not inconsiderable range of size among the waves. I have myself, during a strong gale in the North Atlantic, with a heavy sea of more than ordinary regularity, observed in the course of a morning numerous waves from (an estimated) 30 feet up to a measured height of not less than 40 feet, when the average of all the waves was perhaps 25 feet. It is, I think, clear that in any statement we may make as to the size of the waves in a gale at sea, we ought not to neglect the mention of the larger waves which occur at fairly frequent intervals. These, which I term the *ordinary maximum* waves, are, I think, what seamen really refer to when they state the size of the waves met with during a storm at sea. "About 40 feet" is a common estimate of the height of the larger waves in a severe gale in the North Atlantic, and this estimate is not really incompatible with a recorded *average* of little more than 20 feet.

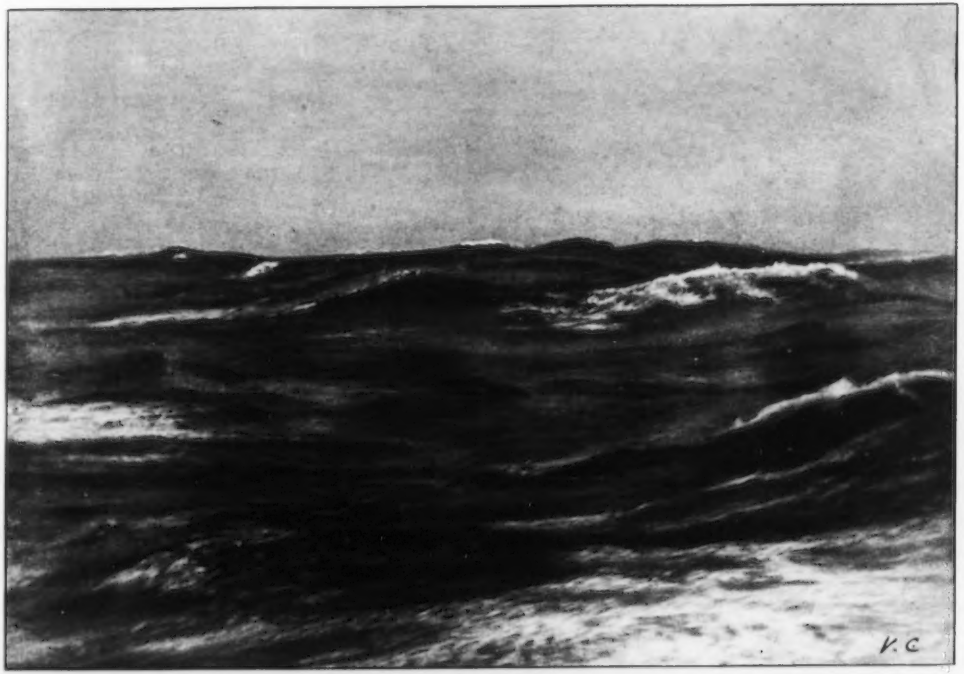
It is difficult to say what may be the greatest height of the solitary, or nearly solitary, waves which are from time to time reported by ships under the term "tidal waves." Excluding causes such as earthquakes, the casual combination of the numerous independent undulations running on the sea presumably produces, not infrequently, two or three succeeding ridges or two or three neighbouring domes of water of

* "Memoire sur la hauteur des vagues a la surface des océans," par M. Coupvent des Bois, *C. R. del' Acad. des Sciences*, 1866, tom. lxii.

† "Observations sur l'état de la mer recueillies a bord Du Dupleix et de la Minerve (1867–70)," par A. Paris, Lieutenant de vaisseau, *Rev. Mar. et Colon.*, vol. xxxi.

‡ 'Les Lames de Haute Mer.'

§ *Quarterly Journal Royal Meteorological Society*, vol. xxv. No. 109, January, 1899.



A GALE IN THE MEDITERRANEAN.

Height of camera above ship's flotation line 22 feet. Angle of vision 40°.

considerably greater dimensions than those of the "ordinary maximum" waves of a storm. Although these large cumulative waves may be frequently produced, yet they will be comparatively seldom observed, because so small a fraction of the ocean's surface is at any one time under human observation. I have received more than one reliable account of such "topping seas" 60 feet high.

The records of observed wave-length (the distance which separates successive wave-crests) are quite as interesting as those of the height of waves. Confining ourselves at present to wave-lengths observed far from a windward shore, we find that during storms the average wave-length seldom exceeds 600 feet, but after storms it is often twice as great. The most numerous observations of the swell which succeeds a storm are those made from the lee shore. Here the number of seconds which elapses between the arrival of successive rollers is readily determined, and from this period the wave-length in deep water can be calculated by a mathematical formula * which has been deduced from the general properties of liquids, and has been approximately verified by fairly numerous observations at sea. Thus on December 29, 1898, in fine weather after a heavy storm, which accompanied the arrival of an atmospheric depression traced from the other side of the Atlantic, I observed at Branksome Chine, near Bournemouth, an uninterrupted series of 139 breakers, the average period of which was 19·35 seconds, corresponding to a wave-length in deep water of 1918 feet, and a wave velocity of 67·6 statute miles per hour. Breakers of similar period have been reported by other observers, although I have not met with another record of so many successive waves of this period. Waves of 1100 and even occasionally of 2000 feet have been reported from ships at sea as a "swell" during calm weather. A swell of 15-seconds period, corresponding to a wave-length of 1153 feet, I have often observed near Bournemouth; yet this is twice the length of the waves usually met with in a storm. Now, there is no reason to suppose that a set of waves really increases in length (which would involve also increase of speed) after the wind subsides; in fact, such a thing is in the highest degree improbable. The longer waves are therefore present during the storm, but not apparent. They must even, I think, be higher then than after the wind has ceased.

I had seen at sea how the increase of wind obscured the swell which was previously running, a familiar fact. I had also noticed, in a storm at sea, that one could sometimes detect the more rapid movement through and past the waves of a something which usually looked either like the shadow of a scudding cloud or else like the brightening which follows the rolling away of a screen of cloud. This also is a common observation, and is explained as being due to "the swell." I knew that the

* Length of wave (in feet) = 5·123 × square of period (in seconds).

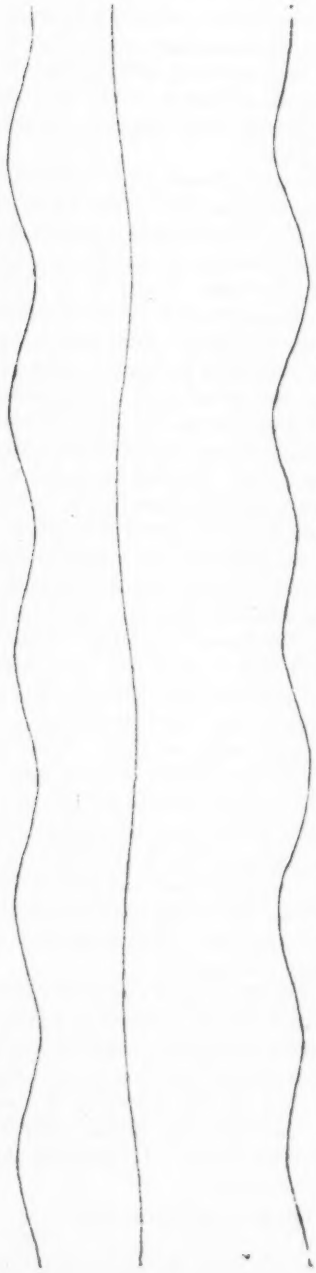


FIG. 2.—COMBINATION OF WAVE 600 FEET LONG AND 30 FEET HIGH, WITH SWELL 1150 FEET LONG AND 20 FEET HIGH. SCALE: HORIZONTAL, 1 IN. = 400 FEET; VERTICAL, 1 IN. = 200 FEET.

swell travels faster than the shorter waves, and that it does not flatten out so quickly after the subsidence of wind.* I was, therefore, and am still, quite prepared to accept the theoretical explanation that there is a real increase of average wave-length when, or where, after or beyond, a storm, the longer waves have run away from, or survived, the shorter ones. This fact, however, did not quite remove the difficulty which I found in explaining what I had seen at sea. I was particularly struck with the great height of the long swells after storms. During the storm they are presumably still higher, and I could not understand their almost complete invisibility. When, however, I came to draw curves combining together a regular series of waves of the length and height of observed storm waves with a second series of the ordinary lengths, observed in the succeeding swell, which is nearly twice as great, I found, to my surprise, that the amplitude of the long swell may, in the figure, be made almost as great as that of the shorter storm wave, and yet be almost invisible in the combined curve (Fig. 2). I have purposely drawn no datum line, because at sea there is no fixed object to supply one. Although no datum line is drawn, yet the margin of the page, or the lines

* *Vide Comptes Rendus*, cxx. p. 1381, and cxxi. p. 15, M. Bousanesq, "On the Gradual Extinction of Waves at Sea."

of the print, make it possible on the figure to detect a slow rise and fall in the general level of the summits of the convexities in the combination curve. But when afloat in a ship, we rise and fall with the water, and the ship responds more perfectly to the swell than to the shorter waves. It is, therefore, so much the more difficult to detect at sea a variation in the level of the summit of the convexities, for there is very little variation relatively to the eye of the observer.

In the "regular sea," of actual experience, still under the action of wind, there is a moderate fractional range in the size of the successive apparent waves and in the distances which separate the summits of succeeding convexities of surface. *The average height from trough to crest will be equal to that of the simple wave drawn in the first line.* Consequently, when the measurements are averaged up, the conclusion would probably be, in the necessary absence of a datum line, that the sea was agitated by one set of waves 600 feet long and 30 feet high, and that there was no other set running at the time which was at all comparable to them in importance.

The appearance, however, is deceptive in this respect, for the motions of the wave-water are very different from what they would be in the absence of the swell, even at the surface, and the depth to which the water is appreciably disturbed is much greater on account of the swell.

Let us now inquire what will be the rate of advance of the convexities in the third line, or, if it be preferred, the apparent speed of the waves (*i.e.* the speed of the apparent waves). It will be alternately rather faster and rather slower than the speed of the simple wave of line one, and the average speed will be the same, so that the velocities will be, on the whole, in agreement with theory, as is found to be the case, and the observer reports that the ship has encountered a single series of trochoidal waves.

Turning to other matters which are noticeable at sea, but not so susceptible of measurement; we see a something running faster than the apparent waves. That effect is not given by the diagram as it stands, but it might be obtained by using a rotating arrangement resembling the old-fashioned toy called "a wheel of life."

Lastly, if, in such a sea as is depicted in this diagram, we were to follow with the eye one of the convexities or ridges, or apparent waves, in its course, we should see that it slowly changed its size and shape. Now, one has been told that if one watches the largest wave at sea, one will presently find that it has diminished, and that the wave *behind* is larger. There is a theoretical explanation for this in a single train of waves.* But recently I have thought I observed that the extra bigness had passed on ahead of the wave I was watching. I did not confirm the observation, unfortunately, and must seek an opportunity of

* Osborne Reynolds, *Nature*, vol. 16, 1877, p. 343.

repeating it. In such a sea as I have drawn here, an extra bigness would sometimes be transferred forwards, *for a short time*, and sometimes backwards.

The combination of undulations at sea is generally referred to, even by those who have studied the subject, as merely momentary, but this is not quite correct when waves are travelling in the same direction. It seems, also, to be generally assumed by those who have written on the subject, that a single train of simple waves can be recognized at once by an observer at sea. In point of fact, however, the time during which one has an apparent wave under observation at sea is, on the one hand, generally short, and on the other the speed of large waves is so great that the perspective effects due to change of position make it far from easy to decide whether the individual mounds of water are simple or compound bodies. Even in the case of the 600- and 1150-feet waves, which ought to be a fairly easy one to disentangle, the apparent wave travels about one-third of a mile before the change of size and shape are complete—that is to say, if viewed from one of the great "liners," the wave has run three or four ship's lengths.

There was another difficulty which I encountered in reconciling theory with experience in the matter of the change from storm-waves to the long swell, viz. the comparative suddenness (as it seemed to me) with which the appearance of the sea changes from the one state to the other. I cannot give numerical data for this, but, judging from my own experience and from the accounts of others, the change from storm waves to swell was much more rapid than I should have anticipated from the theory, as far as I could judge without actual computation. In this case, again, my difficulties to a great extent disappeared when I drew a series of curves of the apparent waves resulting from the combination of simple waves of such lengths as measurements at sea showed to be probable, giving to one of the constituents different degrees of steepness, so as to represent the effect of the more rapid flattening out of the shorter component. I should mention that theory indicates that the rate of flattening of a wave is inversely as the square of the wave-length (Fig. 3). While looking at these figures, we must bear in mind the conditions under which we should observe the sea they represent, viz. with no power to fix on a datum line or datum plane; with very little to guide one as to small differences of level between one crest and another several wave-lengths ahead, and with the eye depending for its information mainly upon the look of things where the curvature of the water surface is sharpest.

If one looks at these two combinations—the first of two waves of very different lengths and of equal *steepness;* the second of two such waves of equal *height*—one will see that in the former the shorter component is obviously subordinate, in the latter the longer component is practically invisible.

FIG. 3.—THE THIRD LINE SHOWS THE COMBINATION OF A WAVE 150 FEET LONG AND 7½ FEET HIGH WITH ONE 400 FEET LONG AND 20 FEET HIGH; THE SIXTH LINE SHOWS THE COMBINATION OF THE FIRST WAVE WITH ONE 400 FEET LONG AND 7½ FEET HIGH. THE FIRST COMBINATION IS OF WAVES EQUALLY STEEP, THE SECOND OF WAVES EQUALLY HIGH. SCALE: HORIZONTAL, 1 IN. = 200 FEET; VERTICAL, 1 IN. = 100 FEET.

It appears probable, therefore, that during the flattening of shorter waves after a storm a critical time comes when the *appearance* of the sea changes quickly from that of comparatively short waves of somewhat irregular length to that of a long swell of somewhat irregular outline (Fig. 4). *There would be no acceleration of the physical changes going on in the water*, and the explanation of the change of appearance is a matter, not of dynamics, but geometry. Before the change came about, the average recorded wave-length would be equal to that of the short component. Then would follow a short time when the sea had a confused look,* and measurement would be impracticable, and after that the measured wave-length would be that of the longer component, which would then be what I call the *dominant* wave.

The *dominant* waves in a storm on the ocean are less steep than those of a large lake or a small sea; or, to put it differently, storm waves 300 to 500 feet long are not so steep as those which are only free to develop a length of less than 100 feet. Now, if the latter were present with the former, we should have a condition similar to that already described as masking the swells of about 1150 to 1900 feet in presence of the waves of about 300 to 500 feet. This, however, is not the case, and we may conclude that the presence of longer waves, *when of a considerable steepness*, hinders the development, and causes the decline, of shorter ones. The air goes into regular undulations superincumbent upon the water-waves, producing an arrangement of travelling eddies which is inimical to the development of intermediate shorter waves.

The phrase "waves mountains high" has become a literary grievance since the real size of waves has been approximately known. Apart from those causes of over-estimate which the late Prof. Rankine explained, there remains some misconception on this subject. No one supposes that waves are as high as mountains, but it does not, therefore, follow that they may not under certain conditions look as high. I have already † drawn attention to a similar case, where, in the absence of objects to give a scale, dunes of pure blown sand produced, under suitable illumination, an almost perfect illusion of mountains. In the case of waves at sea, a somewhat similar effect, probably increased by the motion, is produced as soon as the waves attain such a height that those not far from the vessel overtop the sky-line. It is not so very long ago (when ocean-going ships were mostly of a few hundred, instead of, as now, some thousands of tons) that the nearer waves rose above the deck's horizon whenever the wind freshened to half a gale. From the promenade deck of the great passenger ships, from which in these

* Sometimes a sea looks curiously confused, although there is at the time no crossing of waves.

† *Geographical Journal*, January, 1900, on "Desert Sand-dunes bordering the Nile Delta." I have since seen the same effect, though less perfectly, among the Culbin Sands in Scotland.

FIG. 4.—THE THIRD LINE SHOWS THE COMBINATION OF A WAVE 300 FEET LONG AND 15 FEET HIGH WITH ONE 550 FEET LONG AND 15 FEET HIGH. THE FIFTH LINE SHOWS THE COMBINATION WHEN THE FIRST WAVE HAS THE AMPLITUDE INDICATED IN THE FOURTH LINE. SCALE: HORIZONTAL, 1 IN. = 200 FEET; VERTICAL, 1 IN. = 100 FEET.

days most landsmen get their notion of the open sea, it is comparatively rare to see more than occasional waves near the ship topping the horizon, and as the duration of voyages has been so much shortened by increased speed, it often happens that several ocean voyages may be made without opportunity of realizing that waves can even *look* like mountains. As soon as they do rise well above the horizon the scene suddenly becomes very grand and imposing, and when a thin veil is drawn over the sea by a driving, squally rain, only sufficientiy dense to obliterate the smaller detail while increasing the apparent distances, it is remarkable how the seascape recalls a mountainous landscape. As soon as the crests of the waves subside below the line of sight, their form and dimensions cease to be imposing, and were it not for the speed of their motion, and the fury of the wind wrestling with their surface, the sublimity of the scene would be lost.

I must add here a caution as to another effect of increase in the size of ships upon the apparent height of waves. The old ships were shorter than the ocean wave of ordinary rough weather, which in the North Atlantic may be taken as from 250 to 300 feet. The level of the trough of the wave against the ship's side was the same as the still-water line, and the whole of the wave from trough to crest rose above that line, producing its full effect upon the observer. The modern Atlantic liner, on the other hand, is from 500 to 600 feet long (a few are much longer), so that they usually "take three waves," as the saying is. This means that when one wave-crest is at the bow and another at the stern, there is an intermediate crest at the centre, the ship's length being twice (not three times) the wave-length. Thus the ship is *borne aloft*, so that the still-water line of the ship is considerably above the trough of the wave, and the waves do not produce the full impression of their height. I have noticed an extreme case of this effect in shooting the Lachine rapids of the St. Lawrence in a large steamer. The largest waves were about 7 feet high, but did not rise more than 4 feet above the still-water line of the vessel. *Per contra*, the larger ships are not lifted so high upon single waves as the smaller ships are, and this diminished range of oscillation takes away from the impression of wave-height.

PART II.

In considering the relation between the dimensions of waves and the size of the sheet of water upon which they are formed, we have the assistance of the subjoined table, compiled by T. Stevenson :— *

* *Vide* Article "Harbours," 'Encyclopædia Britannica,' 9th edit.

Locality.	Length of fetch (d) in miles (? geographical).	Observed height.	Height due to fetch calculated from formula $h = 1{\cdot}5\sqrt{d}$.	Height due to fetch calculated from formula $h = 1{\cdot}5\sqrt{d} + (2{\cdot}5 - 4\sqrt{d})$.
		Feet.	Feet.	Feet.
Scalpaflow	1·0	4·0	1·5	3·0
Firth of Forth	1·3	1·0	1·8	3·2
Granton	2·8	4·0	2·5	3·75
Craig Nure	3·5	2·0	2·9	3·9
Granton	6·0	4·0	3·7	4·6
Lough Foyle	7·5	4·0	4·1	4·96
Clyde	9·0	4·0	4·5	5·25
Colonsay	9·0	5·0	4·5	5·25
Dysart	10·0	4·2	4·9	5·5
Invergordon	11·0	3·5	5·0	5·7
Lough Foyle	11·0	5·0	5·0	5·7
Glen Luce bay	13·5	5·5	5·6	6·1
Anstruther	24·0	6·5	7·5	7·7
Lake Geneva (by Minaud)...	30·0	8·2	8·2	8·37
„ (by Buckie) ...	31·0	7·0	8·4	8·5
„ „ ...	38·0	7·0	9·2	9·2
„ „ ...	38·0	8·0	9·2	9·2
„ „ ...	40·0	8·0	9·55	9·5
Macduff	44·5	8·0	10·02	9·9
Macduff	45·0	10·0	10·20	10·0
Douglas (St. George's Channel)	65·10	10·12	12·0	—
Kingstown	114·0	15·0	16·0	15·25
Sunderland (distance measured from Broken Bank)	165·0	15·0	19·3	18·15

It required many years to compile this table, as it gives the observations of "the effects of heavy gales which could be only made at long intervals of time." The author goes on to say that "the formula $h = 1{\cdot}5\sqrt{d}$ . . . indicates pretty nearly the heights of waves during heavy gales, at least in seas which do not differ greatly in depth from those where the observations were made. This formula is, of course, inapplicable where the water is not of sufficient depth to allow the waves to be fully formed, or where it becomes so shallow as to reduce their height after they are formed. It must be observed that in short fetches, such as in narrow lochs or arms of the sea, waves are raised higher during very violent gales than the formula indicates, though it does not appear that such waves go on progressing in height in the same ratio for any considerable distance."

At 144 miles the height calculated from the simpler formula is 18 feet, which accords fairly with the experience of waves in the English channel during easterly gales. But in the Western Mediterranean (off the Riviera) the average height of waves in a storm does not appear to exceed 18 to 20 feet,* though the distance from the windward shore is about 500 miles. Stevenson's formula for wind of maximum strength blowing in a straight line over 500 miles of water would give 37 feet

* See 'The Mediterranean,' by Admiral W. H. Smyth.

as the wave-height, which is beyond the average for severe gales for the oceans, and far beyond our experience of the Mediterranean or of other enclosed seas. The greatest average wave-height observed by Paris in the southern part of the China seas, during a strong north-east gale of several days' duration, was 21 feet. This was with a distance of about 800 miles from the windward shore.

The fact is, that when we pass from lakes and the smaller enclosed seas, we enter a scale of things in which the winds *of violent storms* no longer act simultaneously and in the same direction over the whole stretch of water, and the simple conception of "the length of fetch" (*i.e.* distance through which the wind is acting upon the water) as equal to the distance from the opposite shore has to be replaced by other notions. The strong storm winds, which we are considering, are not part of the general circulation of air, such as we get in the Trades, but are developed in that half of the rotatory storms (cyclones) in which the general direction of the wind is that in which the storm is advancing. The "length of fetch" therefore becomes the distance through which the wind in a cyclone has a velocity above a certain value in a certain direction. The direction we are most concerned with is that of advance of the cyclone, for only along that line can we expect that large *regular* waves will be developed.

Supplementary, however, to this modified notion of the "length of fetch," we must introduce a second notion—that of the "length of run," which in the extreme case is equal to the distance from shore to shore in the direction of the cyclone's advance.

The length of fetch of very strong winds in cyclones can be gathered from what is known of their dimensions, and of the distance from the centre where the strongest winds are developed (about four-tenths of their radius).* The size of a cyclone is smaller in the Mediterranean area than in the oceanic areas,† and the effective length of fetch in the Western Mediterranean for violent winds is much less than the 500 miles quoted above, which, however, would be a possible *length of run* if the cyclone should traverse the whole distance from shore to shore, and keep a nearly constant direction.

On the other hand, the length of fetch of violent winds in the North Atlantic is greater than in the Mediterranean, the cyclone being larger, and this is no doubt an important part of the mechanism by which the larger storm waves of the Atlantic are developed.

The following abstract of Mr. F. J. Brodie's paper on "The Prevalence of Gales on the Coasts of the British Isles during the Years 1871–1900" (*Quarterly Journal Royal Met. Soc.*, 1902) shows the kind of data from which the length of fetch of wind of any given strength in a

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* Sprung, quoted by Waldo, 'Modern Meteorology.'

† 'Encyclopædia Britannica,' 9th edit.: A. Buchan, 'Meteorology.'

cyclone can be arrived at. A severe gale, in that paper, has a wind velocity of not less than 10 of Beaufort's scale, *i.e.* 53 (statute) miles per hour. This velocity was exceeded in 100 gales. Sixteen exceeded 64 stat. miles per hour. In the great storm of December 22, 1894, the wind had a velocity of not less than 53 stat. miles per hour for 14 hours, 64 per hour for 9 hours, and about 76 per hour for 2 hours. And on January 12, 1899, 53 stat. miles per hour for 6 hours, 70–76 per hour for 1 hour. The rate of advance of the storms was as follows: Storms moving from points between W.S.W. and W.N.W to E.N.E. and E.S.E. travelled at 24·8 geographical miles per hour (knots). Out of 264 storms, 60 travelled at more than 30 knots; of these—

25	travelled	31–34	knots	
14	„	36–40	„	
11	„	41–45	„	
4	„	46–50	„	
3	„	51–55	„	
2	„	56–60	„	
1	„	62	„	(a small secondary cyclone)

I think we may take 20-feet average waves and 30-feet "ordinary maximum" waves as the limit in very severe gales in the "seas," and 30-feet average and 45-feet "ordinary maximum" waves as the limit of wave-height for the oceans. Although strong winds will push short waves to a considerable steepness, yet they are not able to attain quite so great a height as somewhat longer waves, because, moving more slowly, their tops give way under the great difference of wind-pressure upon their two sides. Thus the development of the larger waves primarily depends upon the opportunity to attain greater *length*. It is in this respect that our consideration of the size of the cyclone becomes so important for deep-sea waves, especially for explaining the co-existence of the steep storm waves with the swell.

The slighter development of the longer waves is undoubtedly influenced by the dual circumstance that the length of fetch of wind of the required velocity diminishes (the stronger winds only blowing for a short *time* at a fixed station, or for a short *space* in the travelling cyclone), whilst the requisite fetch is greater, for it must be a *large multiple of the wave-length*. Thus the limit of length of the steep waves is rapidly approached from the concurrence of the two causes operating, so to speak, from opposite directions.

Taking T. Stevenson's table of the relation of height of waves to length of fetch, and multiplying the heights by twenty (as a first approximation) to obtain the length,* we see that a wave does not become the dominant form except with a fetch of more than a thousand times its wave-length, thus—

* Cp. Sir William White's 'Naval Architecture,' chap. "Deep-sea Waves."

Length of fetch. Geographical miles.	Height × 20 = wave-length.	Length of fetch. / wave-length
30	8·2 × 20 = 164	1110
40	9·55 × 20 = 191	1272
45	10·2 × 20 = 204	1342
114	16·0 × 20 = 320	2166

Short waves really attain a great steepness * than $\frac{H}{L} = \frac{1}{20}$, so that the numbers at the commencement of this column should be increased, and that in such proportion as to make all the numbers more nearly equal, approaching the last number, which is, roundly, 2000.

Extending these results to 30-feet (average) waves 600 feet long, *i.e.* fully grown ocean storm waves, we see that 30-feet × 20 × 2000 = 227 statute miles, or 197 geographical miles.

A 9-hours' blow, with wind 64 miles per hour, was recorded in the gale of December 22, 1894. With the average velocity of advance of deep depressions from the westward on our coast, viz. 24·8 (say 25) knots, this would give a length of fetch of 225 geographical miles. The height of wave corresponding to this length of fetch in severe gales, as calculated by stretching Stevenson's formula, is 22·5 feet. If the cyclone had the exceptional speed of 60 knots, the length of fetch of the 64-mile-an-hour wind would be 450 miles, which with Stevenson's formula gives a height of 31·8 feet. A thirty-foot wave from the same formula requires a length of fetch of 400 miles. Both this length of fetch and this height of wave are probably more normal in the Southern ocean than in the North Atlantic; the 22·5-foot wave and the 225-mile length of fetch would be more the scale of things there.

If we take the case of a very long swell of 2000-feet wave-length (unusual, but within the records), which is one-third of a geographical mile, then 2000 times this wave-length is 666 miles. The speed of such a swell is 69 knots, and wind of greater velocity than this would only be blowing in a comparatively short strip of even a great cyclone. They would, therefore, not be developed into the dominant wave form,† however strong the wind might be there. The reason for this is most easily understood if we imagine a short series of such waves to exist with the steepness of ordinary storm waves. If 76-miles-per-hour wind last one hour at a fixed station (which occasionally happens on our coasts), and the rate of advance of the storm be 25 miles per hour, then the stretch of water at any time exposed to the above force of wind is 25 miles, which would comprise only 75 such waves.

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* *Vide* M. Bertin's Memoir on Waves, *Proc. Inst. Naval Architects*, 1873.

† *I.e.* the longest of the steep waves. The diagram, Fig. 3, explains the term. In the one curve the shorter waves are obviously subordinate, in the other the longer wave is scarcely perceptible.

Suppose these, or any of them, to have attained considerable steepness, it is evident that the arrangement would be unstable, for there would be so great a difference of steepness between neighbouring waves, that the group would speedily extend itself, multiplying the number of its waves and flattening them out, until the gradation from one wave to the next is almost indefinitely small.*

Although the length of fetch in cyclones is inadequate to the development of the longer observed swells to great steepness, the length of run of the cyclones on the oceans is frequently such as afford much more than the time required for the full development of ordinary storm waves. Thus a cyclone travelling at a little less than 25 knots, the average speed of deep depressions approaching our shores from the Atlantic, travels with the group velocity † of a swell of 16-seconds period (or 1311-feet wave-length), the speed of such waves being 48·56 knots, and their group velocity being, therefore, 24·28 knots. Such a storm, if brewed in mid-Atlantic, and advancing on our shores from W.S.W., would continually reinforce this swell during three days, a space of time equal to 16,200 times the period of the wave. It is an interesting coincidence that the average velocity of deep depressions approaching our coasts from points between W.S.W. and W.N.W. (25 knots) is about half that wind velocity called "A severe gale" by Brodie (viz. Beaufort's "10," 53 statute miles per hour, 46 knots). Of the 60 recorded cases of more rapidly advancing storms, 25 had a speed of 31 to 34 knots, which

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* Compare Osborne Reynolds, *Nature*, vol. 16, 1877, p. 343, "On the Rate of Progression of Groups of Waves, etc."

† In deep water a group of trochoidal waves travelling freely under the action of gravity advances at half the speed of the individual waves. If we follow the motion of the first wave of the group we shall find that it dies out, and the wave behind it has now taken the lead. If, on the other hand, we watch the last wave of the group, we shall soon find that another one has appeared behind it, and the sum total of these two effects may be represented by the following scheme, in which we take the front wave and place it at the back:—

```
1 2 3 4 5 6 7
  7 1 2 3 4 5 6
    6 7 1 2 3 4 5
      5 6 7 1 2 3 4
        4 5 6 7 1 2 3
          3 4 5 6 7 1 2
            2 3 4 5 6 7 1
              1 2 3 4 5 6 7
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In each succeeding horizontal row, the individual waves have moved forward two places, but the group has advanced only one. The late J. Scott Russell's early recognition of two wave velocities appears to have been forgotten. He says, in his Report on Waves, B. A. meeting at York, 1844, "I have found that the motion of propagation of the whole group is different from the apparent motion of wave transmission along the surface; that in the group whose velocity of oscillation is as observed, 3·57 feet per second, each wave having a seeming velocity of 3·57, the whole group moves forward in the direction of transmission with a much slower velocity."

is again about half the maximum observed wind velocity (except in gusts).

Thus we have a dual correspondence of velocities, the individual wave of the longest swells moving with nearly the velocity of the strongest winds, and the group of swells advancing with nearly the velocity of the great storms. When the velocity of wind was calculated with the old "reduction factor," its speed during gales appeared to be much greater than that of the swells which are observed afterwards. The interesting correspondence in speeds only appeared when the newer system of calculating wind velocity was adopted.*

When, as often happens (and as I, for instance, have often observed at Branksome Chine, near Bournemouth), a long swell precedes and predicts the arrival of a storm, the rate of advance of the latter is less than half the speed of this swell in deep water.

A slowly moving storm with violent winds will raise a short steep sea with comparatively little swell in it.

The rate at which a wave flattens out when the wind ceases is inversely as the square of its length. Consequently, in oceans large compared with the areas of cyclonic storms, the surface is found to be heaving with a long swell during the intervals between storms (whence the grand surf which rolls in upon oceanic islands). New storms will not, as a rule, catch up a group of such swells, but cyclones brewed upon the ocean find such a swell already running, and, travelling with it, soon increase its steepness. This is particularly true of the circumterrestrial waters of the southern hemisphere, where a long swell from the west is always running.

It is probable (and experience at sea supports the opinion) that in moderately high latitudes of the southern hemisphere, say 40° to 60° S., the cyclones are on a larger scale than in the corresponding latitudes of the northern hemisphere, where atmospheric movements are more broken up by the alternation of land and water. The bigger waves of the Southern ocean I attribute only indirectly to the greater expanse of water. The expanse of water in the Northern Pacific and Northern Atlantic would amply suffice for the development of larger waves than actually occur there, were the storms which traverse them framed on a larger scale.

On a Numerical Relation between the Average Height of Waves and the Velocity of Wind.

The discussions of numerical relations between the velocity of the wind and the dimensions of deep-sea waves which were essayed by

* The indication of the cup-anemometer used to be multiplied by 3 in order to obtain the velocity of the wind. Meteorologists have now substituted the factor 2·2 (see, *e.g.*, *Q.J.R.M.S.*, vol. xxiii. No. 101).

Desbois, Antoine, and to some extent by Paris, have become obsolete owing to the alteration of the values formerly assigned to wind-velocities corresponding to the conventional numbers into which, on Beaufort's or other scales, the interval from "calm" to "hurricane" is divided for the purpose of recording the strength of the wind.

My own first re-calculations of the results of the French workers is similarly invalidated, and I have therefore re-examined the figures on the following system.

Rejecting the numbers adopted by them for the velocity of wind in metres per second, I fall back upon their record of the "scale" numbers. I calculate by proportion the corresponding number on Beaufort's scale of 0 to 12, and I take the wind velocity corresponding to this in Mr. R. H. Curtis's table of wind velocities. Having done this, I find the relation of the average heights of waves *en pleine mer* to the velocity of the wind to be remarkably accordant in the work of Desbois, of Paris, and of the observers whose observations are collated by Antoine. From the latter's paper I have omitted the figures relating to Paris's observations, so as to keep the third set independent of the other two.

The relation between Beaufort's numbers and the velocity of the wind in statute miles per hour is shown in the following table by R. H. Curtis: *—

VELOCITY EQUIVALENTS FOR ESTIMATED FORCES BY BEAUFORT'S SCALE.

Beaufort's numbers	0	1	2	3	4	5	6	7	8	9	10	11	12
Mean velocity: miles per hour	2	4	7	10	14	19	25	31	37	44	53	64	77
Mean velocity: metres per sec.	0·9	1·8	3·1	4·5	6·3	8·5	11·2	13·9	16·5	19·7	23·7	28·6	34·4

DESBOIS' OBSERVATIONS† OF THE CONNECTION BETWEEN FORCE OF WIND AND HEIGHT OF WAVE.

Wind force on scale 0–8.	Height in feet.
0	1·97
1	3·28
2	4·92
3	7·55
4	10·83
5	15·42
6	20·67
7	28·54

* An attempt to determine the velocity equivalent of wind forces estimated by Beaufort's scale, submitted to the Wind Force Committee, by Richard H. Curtis, F.R. MET. SOC. (*Quarterly Journal Royal Meteorological Society*, vol. xxiii. No. 101).

† *Vide* Cialdi, 'Moto Ondoso del Mare,' p. 543; and *Comptes Rendus*, vol. lxii.

PARIS'S OBSERVATIONS * OF THE CONNECTION BETWEEN FORCE OF WIND AND HEIGHT OF WAVE.

Wind force on scale 0–11.	Height of wave in feet.
4	6·56
5	13·45
6	11·65
7·5	16·57
9	25·43

TABLE SHOWING THE RELATION OF FORCE OF THE WIND AND THE HEIGHT OF THE WAVE, DRAWN UP FROM LATER OBSERVATIONS BY FRENCH OBSERVERS PUBLISHED BY CH. ANTOINE.†

Wind force on scale 0–11.	Height of wave in feet.
3	6·17
4	9·12
5	13·12
6	17·00
7	16·73
8	21·98
9	27·89

From these three tables I have prepared the following combined table by substituting the corresponding number on a scale of 0—12, and then taking the true wind velocity for that number from R. H. Curtis's table.

TABLE SHOWING THE RELATION BETWEEN THE TRUE VELOCITY OF THE WIND IN STATUTE AND IN GEOGRAPHICAL MILES PER HOUR AND THE HEIGHT OF THE WAVE IN FEET, AS DEDUCED FROM OBSERVATIONS BY NUMEROUS FRENCH OBSERVERS EXTENDING OVER MANY YEARS AND TAKING IN ALL THE OCEANS.

No. of wind on Beaufort's scale of 0–12.	Velocity of wind, stat. miles per hour.	Velocity of wind, geographical miles per hour.	Height of wave in feet.	Authority.	Velocity of wind in stat. miles per hour, divided by height of wave in feet.	Velocity of wind in geographical miles per hour, divided by height of wave in feet.
0·00	2·0	1·7	1·97	Desbois	1·01	0·86
1·50	5·5	4·8	3·28	„	1·68	1·46
3·00	10·0	8·7	4·92	„	2·03	1·77
3·60	12·4	10·8	6·17	Antoine	2·01	1·75
4·36	15·8	13·7	6·56	Paris	2·41	2·09
4·50	16·5	14·3	7·55	Desbois	2·19	1·89
4·80	18·0	15·6	9·12	Antoine	1·97	1·71
5·45	21·7	18·9	13·45	Paris ("Grosse Houle")	1·61	1·41
6·00	25·0	21·7	10·83	Desbois	2·31	2·01
6·00	25·0	21·7	13·12	Antoine	1·91	1·65
6·55	28·3	24·6	11·65	Paris	2·43	2·11
7·20	32·2	28·0	17·0	Antoine	1·89	1·65
7·50	34·0	29·5	15·42	Desbois	2·20	1·91
8·18	38·3	33·3	16·57	Paris	2·31	2·01
8·40	39·8	34·6	16·73	Antoine	2·38	2·07
9·00	44·0	38·2	20·67	Desbois	2·13	1·85
9·60	49·2	42·7	21·98	Antoine	2·24	1·94
9·82	52·2	45·3	25·43	Paris	2·05	1·78
10·50	58·2	50·5	28·54	Desbois	2·04	1·77
10·8	61·8	53·7	27·89	Antoine	2·22	1·93
				Average ...	2·05	1·78

* *Revue Maritime et Coloniale*, vol. xxxi., 1871, p. 121.

† 'Les Lames de Haute Mer.' 1879.

This table gives the average of many hundreds of days' observations conducted at various times during a period of about forty years by independent observers, all French seamen of the navy or merchant service, carried out in almost all parts of the oceans ordinarily visited by ships, and from many different vessels (none, however, of the great size of our modern liners, and therefore better for such observations), and shows the average height of the wave, in open sea with sufficient depth of water, to be in simple arithmetical proportion to the velocity of the wind, *the height of the wave in feet being in round numbers one-half of the velocity of the wind in statute miles per hour.*

This result does not express any dynamical law; it is simply the result of averages, but if confirmed by further observation it will have considerable interest for geographers, meteorologists, and for those who have to do with the sea.

Even without further confirmation, it indicates that the uncertainties of the estimations, and the variations of conditions, are not so great as to invalidate comparison of numerical results obtained in different years from different ships and by different observers.

The waves recorded in this table for gentle winds are, not improbably, in part the residual swell of the ocean.

Captain Wilson Barker's table of the relation of wind velocity and wave height is given below in a shortened form:—

RELATION BETWEEN WIND VELOCITY AND WAVE HEIGHT, AFTER D. WILSON-BARKER.*

Velocity of wind in stat. miles per hour.	Height of waves in feet.	Average height of wave in feet.
0	0	0·
3	0–1	0·5
9	1–2	1·5
16	2–3	2·5
24	3–5	4·0
34	6–10	8·0
42 (gale)	10–18	14·0
55 (strong gale)	18–28	23·0
70 (hurricane)	28	28·0

The details of these observations do not appear to have been published, and I gather that the table is rather a generalization from extensive experience, made more precise by measurements, than the result of actual numerical reduction from a systematic record of numbers such as that of the French observers.

If so, it will be better, perhaps, not to introduce these numbers into

* *Quarterly Journal Royal Meteorological Society*, January, 1899.

the general table. For "strong gale" and "hurricane" the results are in pretty good accordance with those of the general table.

To return to the records of the French observers; the above general table of relation of wave-height to velocity of wind is obtained by grouping all the observations without reference to locality. When, however, they are arranged according to localities, as Paris has done in one of his tables, we find that, on the average, the height of wave for a given velocity of wind is somewhat greater south of the Cape of Good Hope, both in the South Atlantic and Southern Indian ocean, than it is further north in the Atlantic or Pacific, and that in these it is in turn somewhat greater than in the China sea.

This is in accordance with all the circumstances whose influence on waves have already been discussed, *e.g.* longer duration of storms, and more residual swell for the rising storms to work upon.

The fact that even an approximately constant relation exists between the height of the wave and a single one of the factors which determines it (viz. wind velocity) is due to the circumstance that the wave soon attains *nearly* its maximum height under a wind of given velocity, the sea being then short and steep; and that what happens afterwards is a rapid increase in the length of the waves, with a very slow increase of height.

The best record of this is given by Paris, who observed, to the east of the Cape of Good Hope, during strong west winds which blew with great regularity for four days, that the height of the waves only increased from 19·69 to 22·97 feet (6 to 7 metres), whilst the length, which was only 370·74 feet (113 metres) on the first day, had attained to 771 feet (235 metres) on the fourth.

It is, indeed, in their great wave-length and almost perfect parallelism that the waves of the Southern ocean differ most from those of the North Atlantic and North Pacific, where the winds veer more rapidly.

Their parallelism, combined with a low point of sight, gives the impression that the waves of the Southern ocean are more regular in wave-length than is actually the case.

In concluding this contribution to the study of deep-sea waves, I may record my opinion that, if the subject is to be much further advanced,* it

* During the revision of proofs I have seen a paper in *Ann. Hydrographie*, xxxi. (1903), pp. 329-341, "Meereswellen-Beobachtungen," von Geh. Admiralitätrat Rottok (issued July 31, 1903), in which reference is made to an investigation by Prof. Dr. C. Börgen, "Ueber den Zusammenhang Zwischen der Windeschwindigheit und den Dimension der Meereswellen, nebst einer Eklärung für das Auftreten von Wellen von langer Periode an frei gelegenen Küstenpunkten" (*Ann. d. Hydr.*, xviii. (1890), pp. 1-11). The former contains, among other matters, an account of photographic and other methods of measuring the height of waves. The latter contains a mathematical treatment of the relations between wind-velocity, wind-duration, and "Seeraum" on the one hand, and the height and length of waves on the other. The calculated results are compared with the measurements of Paris, grouped according to localities ("Atlantic Trades," "West Pacific," etc.).

will probably have to be by taking numerous measurements with recording instruments (of which several have been invented), which will enable the complex wave disturbance to be analyzed into its component simple waves. I trust that the Admiralty may see their way to have this done.*

I have to record my indebtedness first to the late Sir G. G. Stokes, who kindly explained to me points of mathematical theory; secondly, to Captain D. Wilson-Barker, who allowed me to examine some of his original notes of observations at sea; and, lastly, to the Editors of *Knowledge*, who have lent the blocks for the figures, which were originally drawn by me for a series of articles in that journal (January to July, 1901). It may not be amiss to mention that the series of articles was drawn up in connection with the proposal to observe waves from the *Discovery*, and that they, together with additional notes, were supplied by request to Captain Scott, R.N., before sailing, these together forming almost a rough draft for much of the present paper. The chapter on "Deep-sea Waves" in Sir W. White's 'Naval Architecture' (which is in the Library of the *Discovery*) contains the best general review of the subject with which I am acquainted, and my treatment takes the matter up from the point where Sir W. White has left it. Some practical directions for estimating the heights of waves are also given in the 'Antarctic Manual,' having been drawn up by Captain Wilson-Barker for the use of the *Discovery*.

A BATHYMETRICAL SURVEY OF THE LAKES OF NEW ZEALAND.†

By KEITH LUCAS.

THE expedition with whose results this paper deals was, in its original intention, biological. It had as its object the collection of the fauna from a typical series of the lakes of New Zealand in the hope that some light might thereby be thrown upon the distribution of animals within that country. It was, however, obvious from the first that no systematic collection could be made until some knowledge had been obtained of the forms of the lake-basins. At the time when the work was first proposed, in the early part of 1902, there was only one of the New Zealand lakes, Lake Taupo, in which a survey of any degree of completeness had been made. In the remainder there had been made, in a few cases, a small number of soundings, in the majority no observations of depth whatever.

The problem, therefore, presented itself of deciding to what degree of detail it was desirable that the lakes should be mapped, in order

* "The heights of waves and their velocity are subjects on which observations are never amiss" (*vide* 'Admiralty Manual of Scientific Enquiry').

† Map, p. 704.

that the biological work might be most efficiently carried out. On the one hand, a survey involving the study of small details of configuration would demand so great an expenditure of time, that the biological work would be undesirably curtailed, yet too hasty a survey might overlook features of biological importance. And a third point also demanded consideration: the opportunity of mapping the lakes was one which did not seem likely to occur with any frequency, for which reason it was desirable that the survey should be sufficiently detailed to show in outline all the gross configuration of each lake which was visited. On these grounds the decision was finally made, that the survey should be detailed enough to allow of the drawing of rough isobaths in all parts of the lakes, but that minor details of form should be neglected.

In the maps which accompany this paper are shown all the soundings which were made. Compared with the detailed work which has been done in the lakes of Great Britain or of the continent, these soundings must appear sparse, but in New Zealand the time is not yet ready for a bathymetrical survey of such a degree of detail as would far surpass the survey of the surrounding land.

The methods adopted for fixing the positions of soundings were, with small modifications, those made use of in previous limnological work. The essential method was the steering of a straight course between fixed points on opposite shores of a lake, and the making of soundings at known intervals along such a course. This method must depend for its accuracy primarily upon the accuracy with which those points are fixed, which serve as the extremes of lines of soundings. In this particular there was a wide difference between the lakes which were visited. In a few cases, as in Taupo and Rotoiti, for example, actual traverses had been made of the lake-shores, so that it was possible to use as the determining points any prominent objects, such as headlands or the mouths of rivers. The same method was adopted in cases where, in the absence of an actual traverse, the trigonometrical stations situated on the shores were fairly numerous, and at the same time the natural outline of the lake was characterized by such prominent features as could be identified without fear of mistake. Such cases were Waikaremoana and Rotorua. Wakatipu demanded different treatment. There numerous trigonometrical stations are placed along the shore, but the outline affords scarcely any prominent features by which the positions of the stations can be unmistakably recognized. It was in this case necessary to put flags upon the trigonometrical stations, and fix the soundings by direct reference to them. Finally, Manapouri needed even more preliminary work, for there were previously only two stations placed upon its shores, the outline being, except in the immediate neighbourhood of the surveyed township, merely a sketch. In this case it was necessary to carry out a triangu-

lation, by which stations were fixed which served as the end points of lines of soundings.

The degree of accuracy being known with which the end points of each line of soundings were fixed, there remains the consideration of errors which might arise in locating the soundings between those points.

The first of these errors arises when the boat deviates from the

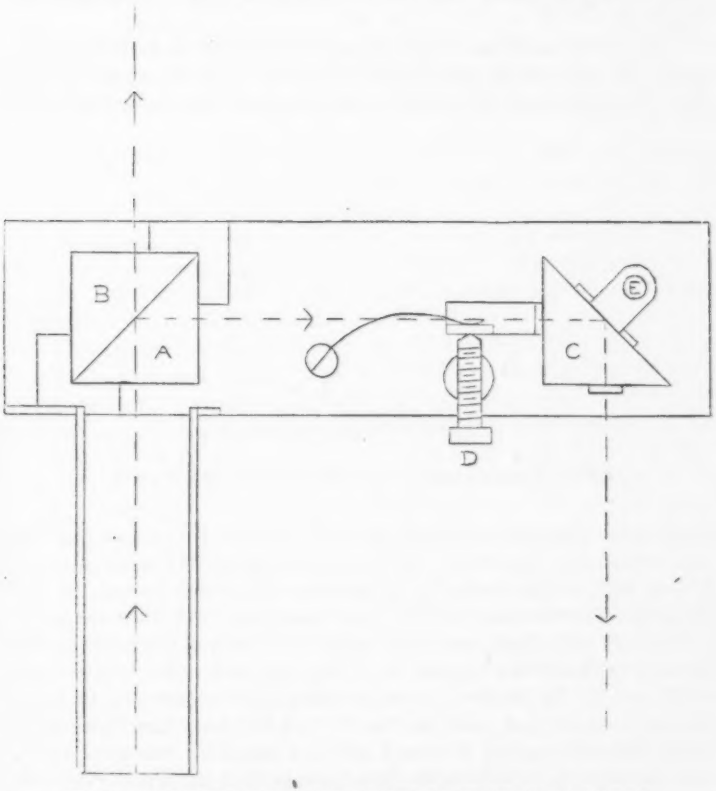

FIG. 1.—INSTRUMENT USED TO CHECK DEVIATION OF LINES OF SOUNDINGS.

straight line which lies between the two determining points. To guard against such deviation an instrument was used (Fig. 1) having an arrangement of prisms similar to that of a sextant, with the exception that the prisms, when once adjusted, were immovable. Any two objects so situated that the straight line joining them passes through this instrument appear in the field of view vertically one above the other.

Derangement of the prisms is readily detected by making two observations of the same objects before and after a rotation of the whole instrument through 180° in either a vertical or a horizontal plane; if the same objects do not coincide before and after such rotation, correction is applied by moving one of the prisms, until the apparent difference between the two observations is halved. Frequent use was made of this instrument while lines of soundings were being carried out, and any deviation from the straight line was quickly seen and corrected.

Though a line of soundings lies evenly between its extreme points, error may still arise in the distribution of the soundings along the line. The instrument used to prevent such errors was a modification of the

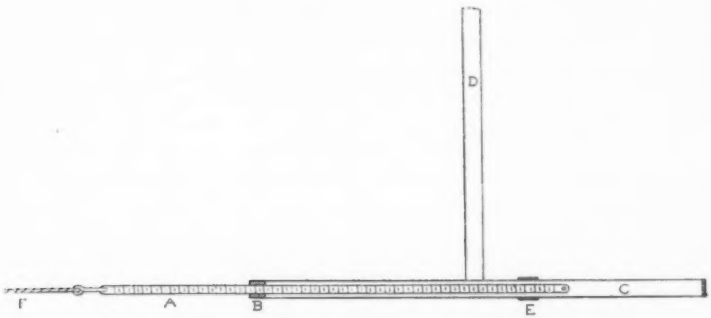

FIG. 2.—RECORDER USED FOR SUBDIVIDING LINES OF SOUNDINGS.

ship's log. The rotator of a "Cherub" log was towed astern of the boat, connected by a short flexible line to the end of a brass screw 2 feet long, which was allowed to run out freely through a nut (Fig. 2). The nut was mounted on trunnions, so that when the screw had run out to its limit, screw and nut could be turned on the trunnions through 180°, and the log-line could be made fast to the opposite end of the screw. In practice, the screw was always started with its inner end opposite a fixed mark on the frame; the boat was then rowed until that end reached a second mark, a sounding was then made, and the screw reversed on its trunnions, so that its opposite end was brought into the starting position. The length to which the screw ran out between successive soundings was kept constant throughout the whole of each line of soundings, except when the distance was halved, which usually occurred near the extreme end of each line.

Cross-bearings taken in the middle of long lines of soundings divided by this instrument have shown its accuracy to be sufficient for the purpose. It certainly has the advantage over any method

which depends for its accuracy on the even rowing of a crew of boatmen. With a Maori crew such a method would have been quite impracticable. The errors from which the log suffers are two. First, the slip of the rotator in the water is variable and depends upon the speed at which it is dragged through the water. This source of error is largely avoided by making the speed of the boat as constant as possible through each line of soundings. Second, the log-line twists up to a certain extent when running, and straightens again while the boat is stopped for sounding. This error does not come in when the travel of the screw between successive soundings is constant, but may become serious when that travel is made to vary, as in taking soundings at half the normal interval near shore. If the interval between soundings is very short, the error arising from this source is comparatively great. It is obviated to some extent by making the log-line as short as possible, with which object the screw is hung over the side of the boat, so that it almost touches the water.

The soundings were made with a Lucas sounding-machine of small size, having a capacity of about 400 fathoms. For the use of this machine I am indebted to the Telegraph Construction and Maintenance Company, of London.

Throughout the whole of the work which is described in this paper, with the exception of that done on the two small lakes Waikare and Whangape, I was accompanied by Mr. G. L. Hodgkin, of Trinity College, Cambridge. He took a very large share of the hard work of the expedition, and his assistance made it possible to carry out much work which could not otherwise have been attempted. In all fairness his name should appear as joint author of the work, but this he too modestly refuses to allow, on the ground that he had no share in the mapping and clerical work of the expedition.

My thanks are due to all those who helped the work in various ways—to Sir John Murray and Mr. Stanley Gardiner, for much valuable advice and help given when the scheme was first proposed; to the officers of the Department of Lands and Survey in New Zealand, for the trouble they took in the preparation of plans of the lakes; and in particular to Mr. Kensington, Under-Secretary for Crown Lands, by whose kindness every facility was afforded to us. And finally, I have to thank the owners of boats on the several lakes, all of whom did their utmost to forward the work, giving their time and help ungrudgingly. Throughout the colony we met with a keen interest in the work, and a readiness to give help, which space does not allow me to acknowledge separately in each case.

A list is given below, showing the areas of the lakes which were sounded, and the number of soundings made in each:—

LIST OF THE LAKES SOUNDED, SHOWING THE AREA OF EACH, AND THE NUMBER OF SOUNDINGS MADE.*

Name of lake.	Area. Square miles.	Number of soundings.	Number of soundings per square mile.
Taupo	238·0	187 (& 436)†	2·6
Wakatipu	112·3	194	1·7
Manapouri	56·0	200	3·6
Rotorua	31·6	176	5·6
Waikaremoana	20·8	370	12·9
Rotoiti	14·2	179	12·6
Waikare	10·7	212	19·8
Whangape	4·0	380	95
Roto Aira	5·0	83	16
Total	492·6	2417	4·9

LAKE TAUPO.

In 1886 a hydrographic survey of Lake Taupo was made by Laurence Cussen, district surveyor, while engaged in the topographical survey of the King Country. The results of this work were published in the *Transactions of the New Zealand Institute* in 1887.‡ The paper was accompanied by a plan showing 436 soundings, an average of 1·8 to the square mile. These soundings showed clearly the main features of the lake-basin, but were hardly sufficient for the drawing of complete isobathic contours; a considerable area, for example, to the west of the island of Motutaiko was without soundings, and the limits of the Horomatangi reef were not clearly defined. It was therefore considered advisable, during the biological examination of the lake made in 1902, to add sufficient soundings to clear up those points which the previous work had left undetermined. With this object in view, 187 soundings were added, the average being thereby increased to 2·6 per square mile.

The chief result of this work has been to show that the Horomatangi reef is not continuous from the shore to the outer end, as was formerly supposed, but consists of an inner reef springing from the shore, and of a completely separate outer mass of conical form. The existence of a bank lying to the north-west of the island Motutaiko has also been demonstrated.

A tracing was obtained from the District Survey Office of Auckland of the original plan made by Cussen in 1886, and, by his permission,

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* Owing to the necessity of reducing the scale of the charts for reproduction, it has been impossible to show all the soundings in some cases. This is so, for example, on the Horomatangi reef, Lake Taupo, and on the shoal which lies at the eastern end of Rotoiti.

† 436 soundings made by L. Cussen in 1886.

‡ "Notes on the Physiography and Geology of the King Country." By Laurence Cussen. *Trans. N.Z. Inst.*, vol. xx. p. 316.

the soundings from that plan have been transferred to a more recent and accurate outline of the lake; they are shown, together with those made in 1902, in the plan which accompanies this paper. Use has also been made of some observations * made by Cussen on the volume of the rivers and streams which enter the lake. From this source are taken those figures in the present paper which show the relative volume of water derived from each part of the catchment area.

The work on Lake Taupo occupied from May 7 to June 19, 1902. The soundings were plotted on a tracing to the scale of 80 chains to the inch, supplied by the District Survey Office of Auckland. From this plan are taken all measurements of the lake which are given in this paper. Since a traverse had been made of the lake-shores, it was possible to fix the positions of lines of soundings by relation to headlands, rivers, and other such prominent points. At the same time, use was made, as far as possible, of those trigonometrical stations which lay on conspicuous and sharply defined positions. The bulk of the work was carried out from the steam-launch *Tongariro*, owned by Messrs. Marshall and Ryan of Taupo, a rowing-boat being only used for such biological work as was done in shallow water near the shore.

Lake Taupo lies near the middle of the North island, extending from 38° 40′ to 38° 57′ S. lat., and from 175° 46′ to 176° 6′ E. long. The lake covers an area of approximately 238 square miles, of which a little more than one-tenth of a square mile is occupied by islands. The greatest length along an axis directed north-east and south-west, between the townships of Taupo and Tokaanu, is 25 miles. The breadth at a point 3 miles from Tokaanu, the south-west end of this axis, is 5½ miles, and from here increases steadily, until it reaches 9 miles at a point one-third of the distance from Tokaanu to Taupo. Beyond this point the western shore falls abruptly back, at Karangahape bluff, to form a great bay, which extends as far as the northern shore, and increases the breadth of the lake to a maximum of 16½ miles. The mean breadth measured at right angles to the long axis is 9·5 miles.

In smaller details the outline is for the most part regular, except along the northern shore, which is broken by several deep bays, the largest and most easterly of which, Tapuaeharuru bay, extends from the body of the lake in a north-easterly direction for 4 miles; at its head the river Waikato leaves the lake close to the township of Taupo. The regularity of the outline is elsewhere broken by two prominent headlands—Motuopa, which lies near the south end of the east shore, and Karangahape, which marks the southern limit of the western bay. There is also a noticeable deltaic spit at the mouth of the inflowing Waikato river.

To the south-east of the middle of the lake there lies the island

* *Trans. N.Z. Inst., loc. cit.*

Motutaiko, which is described by Cussen * as follows: "It is formed of a column of rhyolitic lava ascending perpendicularly from the floor of the lake to a height of 600 feet, half of it being above and half below the water. This island rock is possibly an old volcanic mountain, the looser materials which formed the cone being dispersed by the action of the water and the ordinary subaërial denudation, and now covering the floor of the lake."

The catchment basin of Lake Taupo includes a triangular area of 1250 square miles. The apex of this triangle is formed by the volcano Ruapehu, while its base closely skirts the north shore of the lake. The western side, marked by the volcanoes Ngauruhoe and Tongariro, and by the Hauhungaroa range of mountains, runs in a northerly direction from the apex. The east side, defined by the Kaimanawa and Ahimanawa ranges, runs in a north-easterly direction. Within this triangular area the lake lies eccentrically, close against the north side, and somewhat more towards the west than the east. It would thus appear from the mere disposition of the catchment area that the greater part of the water which enters the lake must be drawn from the east and south sides, less from the west, and far less again from the north. In actual area, indeed, these three larger divisions are distributed as follows: the eastern includes 360 square miles; the southern, which is equivalent to the basin of the Waikato river, 340 square miles; and the western 310 square miles. In their effect upon the volume of water contributed to the lake these differences of area are, however, greatly outweighed by differences of altitude, as the following figures show. The southern area, which includes the Tongariro group of volcanoes, with heights ranging from 6000 to 9000 feet above sea-level, contributes 60 per cent. of the inflowing water. The eastern area, draining heights between 4000 and 4700 feet, supplies 25 per cent. of the inflow; while from the western area, which does not include altitudes greater than 3500 feet, only 10 per cent. of the inflow is drawn.

In the western bay the shores of Lake Taupo are formed of cliffs of rock, varying in height for the most part between 100 and 800 feet above the level of the water, but reaching 1200 feet at Karangahape bluff. The same character of cliff is maintained along the headlands of the northern shore, though in the bays, which lie between these, the land slopes more gently to the water. On the eastern shore there are cliffs of pure pumice, which towards the north, at Ouaha, rise straight from the water to a height of several hundred feet. Towards the south, however, these cliffs become less frequent, and are replaced by gentle slopes of alluvial land or belts of reeds. The most remarkable of these alluvial formations is that through which the incoming Waikato flows; it extends for more than 5 miles inland from the extreme south

* *Trans. N.Z. Inst., loc. cit.*

end of the lake. The western shore, to the south of Karangahape, is formed alternately of high cliffs of bare rock, and of slopes which extend unbroken from the shores to the hills by which the lake is bordered. Beaches of coarse sand and pumice occur at various points around the lake.

In point of depth Lake Taupo is roughly divisible into three portions—the southern end, the greater part of which is included between the 300-feet and the 360-feet contours; the western bay, which lies chiefly between the 360-feet and the 420-feet contours; and the north-east portion, which contains depressions reaching to a depth of 530 feet.

Of these three portions the western bay is the most remarkable for the extreme steepness of its sides and for the unbroken level of its floor. In this bay a depth of 360 feet is always found within a mile of the shore, and in some cases immediately below the cliffs. As soon as this depth is reached the floor becomes almost level, so that at a further distance of 8 miles from the shore the increase of depth is no more than 60 feet. This characteristic formation is met with in a somewhat less extreme form in the south end of the lake; the mean depth is, however, less here than in the western bay, and the slope from the 300-feet line to shore is, conformably with the slope of the land above water, less abrupt. Moreover, the level of the floor is here disturbed in several places. At the extreme south end, for example, the Waikato river has sent out a large deltaic mass, which spreads so far as to limit the deep water in this part of the lake to a narrow channel close to the western shore. The island Motutaiko causes very little disturbance of the level floor, since it rises with almost perpendicular sides. There is, indeed, no change of level to mark its presence at a distance of more than a quarter of a mile from its shore. To the north-west of Motutaiko there is a bank, which measures some 3 miles in length and 2 miles in breadth at its base, and rises 100 feet above the surrounding bottom.

The north-east portion of the lake contains not only the deepest water that is found, but also three remarkable shallows, which are known collectively as the Horomatangi reef. The outer portion of this reef is a conical mass of rock rising from the deepest water in the lake, and reaching within 20 feet of the surface; it measures three-quarters of a mile in diameter at its base, and a few yards at its apex. The apex can be clearly seen through the water, and is thickly strewn with large boulders. A mile and a half to the south-west of the outer reef, and separated from it by a channel over 400 feet in depth, there is a second mass of rock, of similar formation, having however a broader base and a flat top of about a mile in mean diameter. The boulders here reach within a fathom of the water's surface. This inner reef is again separated by a channel 200 feet in depth from a terrace, covered by less than 20 feet of water, which rests against the shore along a line 3 miles in length, and runs out into the lake in the form of a triangle

for a distance of a mile and a half. Immediately to the west of the outer Horomatangi reef there lies a depression, in which the deepest sounding recorded is 534 feet. This depression is flanked by two others, which also exceed 480 feet in depth. The 420-feet contour closely embraces these three depressions, and also includes the outer Horomatangi reef. It approaches within half a mile of the headlands of the northern shore, but does not enter the bays by which these headlands are separated; on the eastern side it maintains a distance of 3 miles from the shore, and in a southerly direction is limited by the middle Horomatangi reef, and by the bank which lies to the north-west of Motutaiko. The 360-foot contour, which has been mentioned above as closely following the shore-line of the western bay, skirts along the northern shore within half a mile of the headlands, sending long tongues into several of the bays, falls back to a distance of about 2 miles from the eastern shore, and is limited in a southerly direction by the same shallows which limit the 420-foot contour. Unlike the latter, however, the 360-foot contour sends a long tongue southwards, between the two shallows, almost as far as the north shore of Motutaiko.

Hot Lakes District.

The Hot Lakes district of New Zealand includes seven lakes—Rotorua, Tarawera, Rotoiti, Okataina, Rotoma, Rerewhakaitu, and Rotoehu—ranging in area from 31 to 3 square miles, besides many of smaller size. The lakes within the district cover a total area of between 85 and 90 square miles. They are conveniently spoken of under the common title of "The Hot Lakes," both owing to their actual proximity to one another, and because their shores are marked, in the majority of cases, by the presence of geysers and hot springs. It is well to note, however, that, though lying close together, and all draining into the Bay of Plenty, these lakes do not belong to a single river-system; nor, indeed, are they the only lakes in New Zealand which are marked by thermal activity, for the hot springs of Tokaanu and of Waipahihi pour their water into Lake Taupo, and there is a hot spring rising from the bottom of Lake Waikare.

The present Bathymetric Survey is concerned with only two of the hot lakes, Rotorua and Rotoiti, which are drained by the Okere or Kaituna river. The combined area of these two lakes is 45·8 square miles, or rather more than half the total area of the lakes contained within the district.

Rotorua.—The sounding of Rotorua occupied seven days, namely, July 5 to 8, and 16 to 18, 1902. The number of soundings made was 176, being an average of 5·6 to the square mile. The soundings were plotted on an outline obtained from a lithograph, on a scale of 160 chains to the inch, provided by the District Survey Office of Auckland; from this plan are taken those measurements of the lake and of its catchment

area which are given in this paper. All the work was carried out from the steam-launch *Hinemoa*, the property of the Hot Lakes Steam Navigation Company of Rotorua.

The area of Rotorua is 31·6 square miles, exclusive of the island Mokoia, which occupies 0·9 square mile. In superficial outline the lake consists of a roughly circular basin, 6 miles in diameter, broken by an irregular southern extension, which increases the length in a direction north and south to a maximum of 7½ miles. The mean breadth measured at right angles to the long axis is 4·2 miles. The western side of the lake, from the headland Kawaha northward to Hamurana, closely follows a circular outline, but the north shore is almost straight, running nearly due east from Hamurana to the Ohau stream. The east shore, too, taking a direction nearly due south from the latter point, continues in a straight line as far south as Te Ngae; beyond Te Ngae it turns slightly to the west, and maintains this direction, unbroken except by the headland Te Anu-o-Tokerau, till the extreme south end of the lake is reached. The southern part of the lake, south of a line drawn between Kawaha and Te Anu-o-Tokerau, is formed of two bays, a larger on the shore of which the village of Ohinemutu stands, and a smaller which forms the most southern extreme of the lake. The island Mokoia, situated in the northern circular basin to the east, and somewhat to the south of its middle point, rises to a height of 603 feet above the surface of the lake.

Rotorua lies in the north-east corner of a nearly circular catchment basin 16 miles in diameter, and 190 square miles in area. From the edge of this basin, where the highest points lie at 2500 feet above sea-level, the land falls, for the most part in a continuous curve, till it reaches the lake at an elevation of 915 feet. The symmetry of the basin is, however, disturbed by Ngongotaha, a hill which rises to a height of 2554 feet above sea-level, a little to the south-west of the basin's central point, and also by a lower range of hills which proceeds in a south-easterly direction from Ngongotaha.

Through the Hemo gorge, a break in the latter range of hills, there comes one of the largest streams which enter the lake, the Purenga stream, draining the southern extreme of the catchment basin. The remaining four large streams, the Utuhina, the Ngongotaha, the Komutumutu, and the Awahou, all enter the lake on its western side, an arrangement which results from the north-easterly position of the lake within its catchment basin.

Besides these streams, there are also many springs around the lake supplying a considerable body of water. The majority of these are hot springs, the one remarkable exception being the Hamurana spring, which lies close to the north shore. This spring yields a large volume of cold water—so large, indeed, as to form a river by which rowing-boats may pass from the lake to its extreme source.

The hot springs occur in two main groups, one on the north-east side of the lake at Tikitere, and a second on the south shore. The latter group extends from the mouth of the Purenga stream along the whole of the south shore, to a point three-quarters of a mile beyond the native village of Ohinemutu. In this group the springs are usually close to the water's edge, or actually in the lake; near Sulphur point in particular, where the water is shallow, there are many rising from the floor of the lake, their presence being marked by disturbance of the water's surface, and by a milkiness of the water due to sulphur held in suspension. One large part of this group lies, however, at a distance of about a mile from the lake-shore, at Whakarewarewa. The water derived from this source falls into the Purenga stream, and so reaches the southern end of the lake. A single hot spring known as "Hinemoa's Bath" is found on the shore of Mokoia island.

The outlet of Rotorua is by the Ohau stream, which, after crossing a belt of low-lying flat land little more than half a mile in width, enters the west end of Rotoiti.

The shores of the lake are chiefly formed by sandy beaches. Low cliffs are, however, found along the north and north-east sides, and there are irregular masses of rock fringing the water-line at Kawaha.

Within the basin of Rotorua isobathic lines have been drawn at intervals of 15 feet. The first of these isobaths maintains in general a distance varying between a quarter of a mile and half a mile from the shore, but shows two notable deviations. The first of these is at Motutara, the headland separating the two bays which form the south end of the lake, where the 15-feet line approaches within a few chains of the shore, though it completely fails to enter the bay which lies to the east of Motutara. As has been already pointed out, this part of the lake is marked by extraordinary thermal activity, which no doubt is the cause of these irregularities of the floor. The bay to the east of Motutara is indeed of irregular depth, with rocky shallows reaching in some places to the water's surface; while to the north-east of Motutara there is a narrow deep depression, the deepest, in fact, which the lake contains, lying within 20 chains of the water's edge. The second deviation which the 15-feet contour shows consists in a near approach to the north shore between Ohau and Hamurana, at a point where there are steep cliffs rising from the water-line.

The 30-feet contour exhibits the same general characteristics, excepting small irregularities, as the 15-feet line, and approaches the shore at Motutara and on the north shore in a similar way. There are, however, two areas, one in the Ohinemutu bay, and a second to the south-east of Mokoia, over which the slope of the lake-floor is lessened, so that the 15-feet line and the 30-feet line show a separation wider than elsewhere.

The first two contours completely enclose Mokoia island, but the

45-feet line fails to do so. The depression which this line includes is crescentic, closely embracing Mokoia island on all sides except the south-east, where its two horns are separated by a distance of three-quarters of a mile. In a north-easterly direction it reaches within a quarter of a mile of the north shore between Ohau and Hamurana, and southward it extends to a point a few chains distant from Motutara. Otherwise it maintains a distance varying between 1 and 2 miles from the shore.

Within this crescentic depression there lie two separate hollows, one, of similar though more regular form, bent closely round the north-west side of Mokoia, and a second, of much smaller size and circular in outline, lying close to the shore of Motutara. The larger of these hollows must be considered as the normal continuation of the general slope of the lake-floor. It is enclosed by the 60-feet and 75-feet contours, of which the former, starting from a point 1½ mile to the south of Mokoia, reaches within a quarter of a mile of the north shore; on its west side it is widely separated from the 45-feet contour. The 75-feet contour encloses a far smaller area, though following the regular crescentic form: the deepest sounding taken within it was 84 feet.

The smaller depression, which lies near Motutara, shows on the 60-feet line an oval outline less than half a mile in its longest dimension. At the 75-feet contour it is reduced to a diameter of about 20 chains, and beyond this depth grows rapidly narrow, till a depth of 120 feet is reached in a hole probably not more than a chain across. It appears, therefore, that this smaller depression is a local accident of thermal origin, not to be considered as forming part of the general depression which constitutes the lake-basin.

The sublacustrine slopes of Mokoia are far steeper than the average slopes of the lake-floor; on the north-west side, for example, the mean gradient from the shore of Mokoia to the deepest water is 1 in 16, while the opposite gradient, from the deepest water to the north-west shore of the lake, is 1 in 190. Mokoia thus rises abruptly from the east slope of the lake-basin to a height above the water seven times greater than the depth of the deepest water by which it is surrounded.

Rotoiti.

The sounding and dredging of Rotoiti were carried out between July 9 and July 15, 1902. Since there was no boat available on the lake at the time when the work was to be done, a small steam-launch, owned by the Hot Lakes Steam Navigation Company, was taken from Rotorua through the Ohau stream, and was used for all the work which was done on the lake. Mr. D. I. Barron, district surveyor of Rotorua, was at that time engaged in making a traverse of the shores on the north side of the lake, and by his kindness our party was allowed to join his camp at Tapuaeharuru.

The plan on which the soundings were plotted, from which also the measurements of the lake are taken, was compiled partly from the traverse which was then in progress, and partly from the lithograph which has been already mentioned in connection with the plan of Rotorua. The outline of the eastern part of the lake, as far west as a line joining Parangha to Ngarehu, is derived from the former source, the western part from the latter. In the western part it was found necessary to make some change in the outline shown in the lithograph, for this was so inaccurate that some lines of soundings, when plotted upon it, even failed to fall within the lake. It is hoped that this alteration, though pretending to no accuracy, may so indicate the position of the soundings, that they may be accurately replotted if at any time a complete traverse of the shores is made.

Rotoiti covers an area of 14·2 square miles. The general trend of the lake is in a direction east and west, the length measured on a straight line from Ohau to Tapuaeharuru being 8·4 miles. On a line drawn from Motu Ohiwa to Tapuaeharuru freely through a series of points midway across the lake, the length is 10·7 miles. The greatest breadth at right angles to this line is 2·2 miles, the mean breadth 1·33 mile.

The lake is divided by a narrow channel between the points Tu Moana and Rewiti into a larger eastern and a smaller western basin, the areas of these being 11·38 and 2·82 miles respectively. The small western basin is curved in the form of the letter C, and its outline is much broken by small bays. The eastern basin at first continues the curve of the western in a north-easterly direction; then, after narrowing opposite the headland Ngarehu, widens and turns in a direction a little south of east.

Rotoiti lies in a narrow eastward extension from the Rotorua catchment basin, the two basins being only separated by a strip of low-lying land about half a mile across, through which the Ohau stream flows. The depression which forms the basin of Rotorua is, in fact, continued right through Rotoiti and Rotoehu, for the land which separates Rotoiti from the neighbouring lakes lies extremely low. The catchment basin of Rotoiti has an area of rather less than 40 square miles, whereas the Ohau stream brings the catchment from the Rotorua basin, whose area is 190 square miles. It follows that the bulk of the water which enters Rotoiti enters it by the Ohau stream. Excepting the Ohau, no streams of considerable size enter the lake. The outlet is by the Okere or Kaituna river, which leaves at the north-west extremity of the lake. Rotoiti has one small group of hot springs situated on its shore at Manupirua.

The immediate shores of Rotoiti show a remarkable correspondence with the form of the lake-basin in their neighbourhood. Round the western basin, for example, the shores are in many places ill defined,

consisting of belts of reeds or sandy spits, and here the water is uniformly shallow, in no place exceeding a depth of 90 feet. There are, moreover, in this part of the lake several shallow bays, of which the most remarkable are Morea bay and Weta bay; the latter is noticeable for its curious outline and for its narrow entrance.

In the eastern basin, that part of the lake which lies to the east of Rewiti and Tu Moana, the shores rapidly change their character, marshy ground disappearing and being replaced by broken rock or cliffs. With this change there comes a comparatively rapid deepening of the lake-basin. The deepest water—230 feet—occurs in a small depression which lies fairly close to the north shore of the lake, and about 3 miles from its eastern end. To the west of this deep depression the north and south slopes of the lake-basin resemble one another fairly closely, and there is no striking difference between the characters of the shores from which they spring. In the more eastern part of the lake, however, there is a sharp differentiation between the north and south shores, a differentiation which is caused by a change of the north shore from a succession of low cliffs interrupted by shallow bays to a continuous line of high cliffs of rock, while the south shore maintains its former character unchanged. The cliffs of the north shore culminate at Matawhaura, close to the east end of the lake, where they reach a height of about 900 feet above the surface of the water; they do not, however, cease at this point, but continue their eastward course well beyond the end of Rotoiti.

The sharp fall of this line of cliff, where it borders the lake, is continued to a depth of about 150 feet or more below the surface of the water, and beyond this depth the lake-floor becomes almost level. The slope from the opposite south shore is far more regular and less steep, so that in a transverse section, taken across the lake at a point about 2 miles distant from the eastern end, the south slope is seen to fall with a gradually decreasing gradient for a distance of 1½ mile, and then to meet the north slope, which has accomplished the whole fall in a horizontal distance of 60 chains.

The correspondence which is thus seen to exist between the nature of the immediate shores and the form of the lake-basin in their neighbourhood does not extend to the land beyond the shores. There is in Rotoiti no such relation between the depth of the water and the height and gradient of the surrounding country as is found in valley lakes such as Wakatipu.

The few small islands which occur in various parts of Rotoiti cause no considerable disturbance of the general form of the lake-basin. There is, however, one noticeable shoal, lying on the southern slope of the eastern basin, distant 1½ mile from the lake's eastern end. The shoal is circular in outline, with a diameter of a quarter of a mile at its base. Its apex reaches within 30 feet of the water's surface.

Measurements of the gradient of the lake-floor made along the lake's curved axis show a mean of 31 feet to the mile from the west end to the deepest depression, and a mean of 72 feet to the mile from the latter point to the east end.

(*To be continued.*)

PEAT MOORS OF THE PENNINES: THEIR AGE, ORIGIN, AND UTILIZATION.*

By C. E. MOSS, B.Sc.

THE conclusions stated in the present paper apply probably to the whole of the Pennines, although detailed examination of those hills by the writer has only been undertaken of that portion which lies between Ingleborough and the Peak. The whole of the latter area has recently been traversed, and its vegetation and general condition surveyed, by Dr. Smith, Mr. Rankin, and myself. Mr. Lewis has also surveyed a portion of the Pennines to the north. Papers and maps giving some of the results have already appeared in the *Geographical Journal*.† These maps serve excellently to illustrate the present paper, and to them students are referred.

It has been found that, speaking broadly, the Pennine moors are of three kinds, which occupy definite relations in regard to each other. By far the most extensive are the cotton-grass moors (Fig. 1). These moors are dominated by one or other of the two cotton-grasses (*Eriophorum vaginatum* and *E. angustifolium*), or in certain easily defined exceptional cases, one or other of the associates of the cotton-grasses, such as bilberry (*Vaccinium Myrtillus*), crowberry (*Empetrum nigrum*), cloudberry (*Rubus Chamæmorus*), or cowberry (*Vaccinium Vitis-Idæa*). The presence of peat is important to the geographer in determining the value of land for agricultural purposes, in determining the distribution of certain animals and plants, and in indicating certain possible industries. The cotton-grasses grow on peat, which is seldom less than 5, often 10, and occasionally even 20 to 30 feet ‡ deep. Surrounding the cotton-grass moors is an irregular fringe either of heather moors or of grassy moors. The heather moors (Figs. 2 and 3) occupy the flatter edges and flanks of the cotton-grass moors, and the flatter, isolated patches of moorland. Heather (*Calluna Erica*) is here the dominant plant. It grows on peat, which, however, is seldom so much as 5 feet deep, and is usually much shallower. The peat of the heather moors, besides being shallower, is browner and drier than the peat of the cotton-grass moors. The grassy moors occupy the steep shaly edges of the peaty summit-plateaux, and also those portions where the rocks of Carboniferous Limestone come to the surface. On the grassy shaly declivities (Fig. 4) only a very thin layer of peat is present, and this layer does not actually accumulate. Even this layer, on the porous limestone rocks, is reduced to an imperceptible minimum. §

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* Paper read before Section E, at the Meeting of the British Association, Southport, 1903. The photographs which illustrate this paper were taken by Mr. W. B. Crump, M.A. (Halifax), who has kindly placed them at my disposal.

† The *Geographical Journal*, May and August, 1903, and March, 1904.

‡ 1 foot = 0·3048 metre.

§ Though peat is decidedly rare on the Carboniferous Limestone, it is not altogether unknown there.

FIG. 1.—COTTON-GRASS MOOR IN JUNE. COTTON-GRASS IN FRUIT.

FIG. 2.—HEATHER MOOR IN SEPTEMBER. HEATHER IN FLOWER.

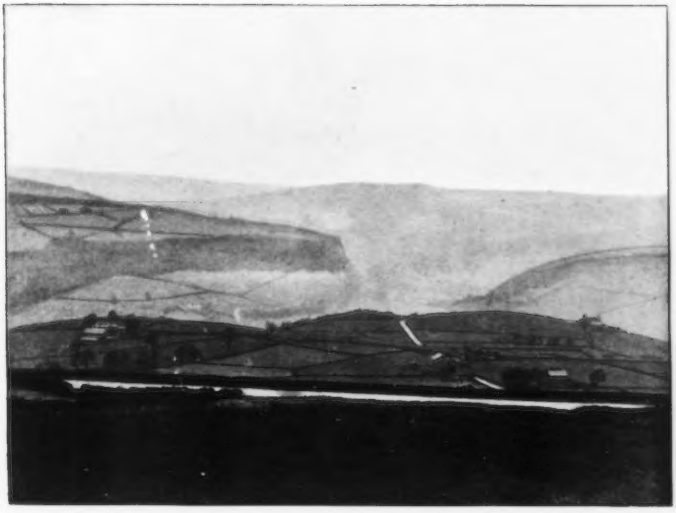

FIG. 3.—HEATHER MOOR ABUTTING ON AREA OF UPLAND CULTIVATION.

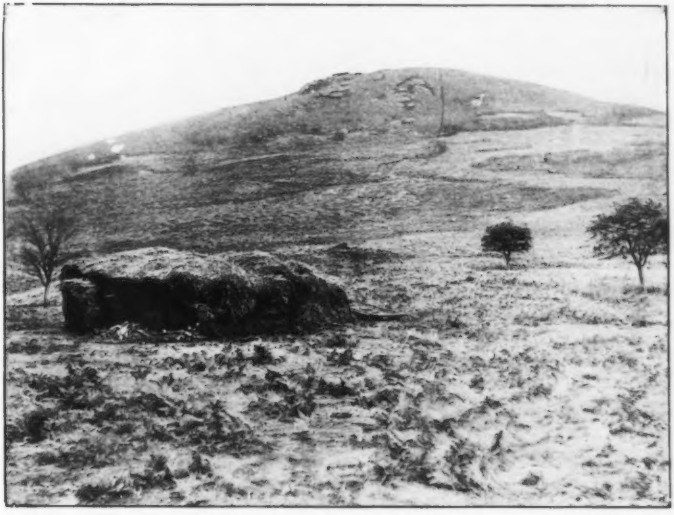

FIG. 4.—MOORLAND SLOPE OF BRACKEN AND GRASS. STACK OF BRACKEN LITTER IN FOREGROUND. THE TREES ARE HAWTHORNS.

An attempt is made in the present paper to explain how and when the peat moors on the Pennine summits originated, and to briefly indicate to what uses they may be put.

There is a remarkable consensus of opinion that the peat moors of the present day occupy the sites of former forests. This opinion is not confined to British or to modern authors: it is met with in British, American, and Continental writings for the last two hundred and fifty years. To quote authorities would be to give the bibliography of the subject.* Does this conclusion apply to the Pennines? I think it does; for although at the present time natural woods cease when an altitude of 900 to 1000 feet† is reached, yet there are many indications which agree in pointing to the conclusion that the Pennines were formerly much more extensively wooded than they are to-day.

Place-names implying the existence of woods on the Pennine slopes are exceedingly numerous. The name "forest" does not, perhaps, necessarily imply a tree-clad area; but that some at least of the numerous, but now treeless, Pennine "forests" and "chaces" were as a matter of fact partially tree-clad is a matter of history.‡ "Shaws" and "shays"; "heys," "hays," and "haighs"; "hursts"; "woods"; "withs"; "cloughs"; "dens" and "deans"; "ghylls"; and "lumbs" exist by the hundred in what are now almost treeless regions. The place-name "royd," which means a clearing, implies a pre-existing wood; and it has been shown§ that there are over a hundred "royds" in the single parish of Halifax. Therefore, if from place-names alone, the conclusion is justified that the Pennines were extensively tree-clad in Saxon and Danish times.‖

As regards the Pennine summits, however, the evidence from place-names seems to point in a different direction. Not only are place-names signifying woodland much less numerous at the higher altitudes; but such as do exist usually have some further qualifying name attached to them, indicating their derivation from lower levels. For example, Ashop Moor at 1900 feet and Ashop Head at 1750 feet lead down to Ashop river and Ashop clough at 1250 feet, and these to Upper Ashop at 900 feet and Nether Ashop at 800 feet. While the Pennine slopes are remarkable for the immense number of place-names signifying or implying either the existence of woodland or the existence of particular trees, on the Pennine summits the outstanding place-name is "moss," meaning a "morass."¶ The following are a few examples: Holme Moss, Buckstones Moss, Harden Moss, Featherbed Moss, Close Moss, Shelf Moss, Moss Moor and Field of the Mosses. The place-name "moss," in fact, is co-extensive with the present area of the deep peat moors tenanted by cotton-grass and its associates. Therefore, if from place-names it is concluded, as there seems to be no alternative but to conclude, that the Pennine slopes were largely tree-clad in Saxon and Danish times, it must also be concluded that at that period the Pennine summits were covered with extensive morasses.

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* See Plot's 'Natural History of Staffordshire' (1686); Rennie's 'Essays on the Natural History and Origin of Peat Moors' (1810); Geikie's 'Great Ice Age' (1877); Leavitt's 'Facts about Peat' (Boston, U.S.A., 1867); Larbalétrier's 'La Tourbe et les Tourbrières' (1900); and Graebner's 'Die Heide Norddeutschlands' (1902).

† 100 feet = 30·48 metres.

‡ See such works as 'History of the Forest of Knaresborough.'

§ See *Halifax Naturalist*, vol. iii.

‖ See works on Place-names. The *Halifax Naturalist* contains numerous notes and articles on local place-names, mostly written by C. Crossland, F.L.S.

¶ Other place-names on the Pennine summits signifying "morass" are "carr," "wham," "fen," "moor," "mere," "mire," "marsh," "swamp," and "bog."

The presence of buried timber in the peat also points to the existence of a primitive Pennine forest. The late Mr. Lucas,* of the Geological Survey, has recorded remains of birch up to 1725 feet, of hazel up to 1650 feet, and of oak up to 1250 feet; and he concludes that a general lowering of several hundred feet has taken place in regard to the Pennine woods since the coming of the Danes. Records of buried timber occur in almost every parish,† though most of it by this time appears to have been carried away and burnt as fuel. Below 1500 feet such records are fairly numerous: from 1250 to 1500 feet they are rather rare: above 1500 feet a few records exist. The paucity of records above 1500 feet is possibly due to decreased facilities of observation in not easily accessible districts, and possibly to another cause which will be suggested later in the paper.‡ The remains of birch, oak, alder, Scots pine, mountain ash, hazel, and willow have been found in the Pennine peat, the three first being the commonest. Taking these records in connection with the evidence from place-names, the conclusion seems to be indicated that not only were the Pennine slopes tree-clad in Saxon and Danish times, but also that at some prior date the summits too were at least partially covered with woodland.

There is no evidence from the continental range of the timber trees native to the Pennines which in any degree militates against this conclusion, as in even more northern latitudes the birch ascends to 3000 feet, and the oak to 1600 feet.

A study of the present distribution of native trees on the Pennines further strengthens the conclusion that a Pennine forest formerly existed; for while natural woods cease at an altitude of 900 to 1000 feet, yet small patches of scrub (Fig. 5) of apparently indigenous trees and shrubs are found several hundred feet higher; and isolated trees, also apparently indigenous, are found in sheltered spots up to about 1500 feet (Fig. 4).

It is probable, then, that this primitive forest extended over almost the whole of the Pennine slopes, and over much, at least, of the Pennine summits. On the slopes, *i.e.* from 1250 feet downwards, it is likely that the oak was the dominant tree; while from that altitude upwards to at least 1750 feet, the dominant tree was probably the birch.§ Mountain ash, alder, hawthorn, hazel, and willow were probably also common.

It is difficult to be certain of the condition of the Pennines in early Roman times. Roman historians agree in asserting that at that time Britain as a whole was remarkably well wooded. They are also unanimous in declaring that the Britons utilized these woods as hiding-places from which to sally forth and inflict loss on the Roman legions. Hence it is not surprising to find, in British‖ writers on general history as well as on peat, an almost unanimous opinion that the Roman generals destroyed much primitive woodland. It is natural that Roman writers lay but little stress on this aspect of the Roman occupation; but there are one or two passages in Roman writings that lend support to this view.¶ It is quite

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* See Lucas's 'Studies in Nidderdale;' also *Proc. Yorks. Geol. and Polyt. Soc.*, 1881.

† See such works as 'History of the Parish of Kirkburton.'

‡ See p. 666.

§ On the Carboniferous Limestone, probably the ash (*Fraxinus excelsior*) was the dominant tree.

‖ In addition to the works previously mentioned, see Steele's 'Natural and Agricultural History of Peat-moss' (1826), and early numbers of *Phil. Trans.* Also see such works as Green's 'Making of England,' and Wright's 'The Celt, the Roman, and the Saxon.'

¶ "The Britains forthwith sent Embassadours unto him [Severus] for peace. . . . Leaving his sonne Geta, . . : himself with Antoninus went into the further parts,

FIG. 5.—SCRUB OF BIRCHES, HAWTHORNS, ETC., ABOVE THE UPPER LIMIT OF OAK WOOD.

certain that such circumstances existed on the Pennines as would abundantly justify, from the military point of view, the Roman generals in much destruction of woodland; and though the Romans are more renowned, and justly so, for the building up of their conquered territories, there is no reason to think that during the actual process of conquest their generals were guilty of undue leniency. There is no lack of evidence that the Pennines were completely subjugated by the Romans, and that for centuries the district was altogether under their sway.

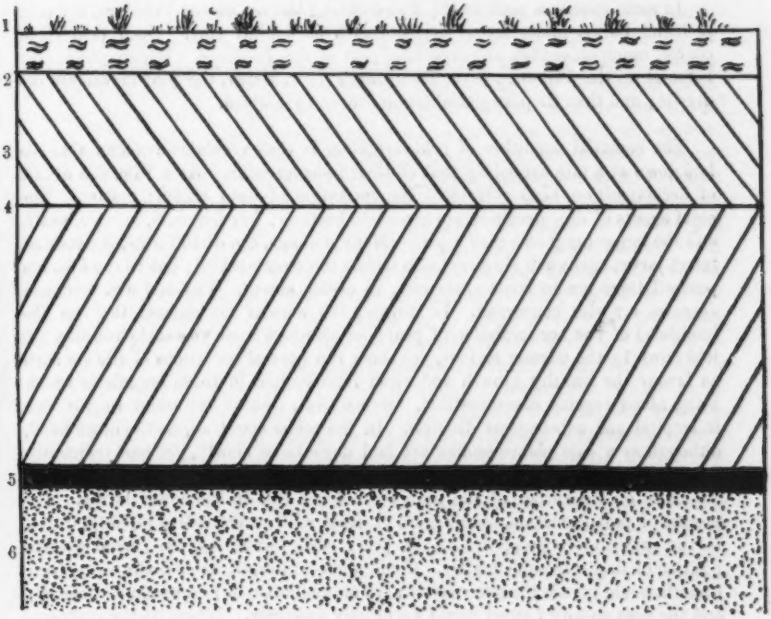

FIG. 6.—DIAGRAMMATIC SECTION OF PENNINE PEAT. (1) GROWING PLANTS; (2) PLANT-REMAINS, NOT SUFFICIENTLY DECOMPOSED TO BE YET TERMED "PEAT;" (3) BROWN PEAT; (4) BLACK PEAT; (5) THIN LAYER OF MOOR-PAN; (6) UNDERLYING SUBSOIL—ON SANDSTONE, SHALE, OR GLACIAL CLAY.

Apart from Roman writings, which in themselves are conclusive, there is abundance of archæological evidence pointing in the same direction. A few Roman place-names survive: Roman relics have been found: Roman camps have been unearthed: several Roman roads cross the Pennines. It is worthy of note that

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where being occupied in cutting downe woods, making bridges, and drying up the meres, he fought no battell: howbeit, what with the ambuscadoes of enemies and what with sicknesse, he lost fiftie thousand of his men: Thus writeth Dio."

"Herodian hath remarked that in certain light skirmishes, whilst the barbarous Britains kept the fennie bogs, and most thick woods, out of which they might more safely assaile the Romans, he [Severus] had the upper hand."—See Camden's 'Britannia,' p. 69 (Eng. edit., 1610).

the remains of the Roman roads now found on the Pennines do not lie on the peat, but on the subsoil.

At the advent of the Romans, the Pennines were inhabited by the "Britons"—the "neolithic men." This primitive race has also left abundant traces of its occupation. Of these, flint implements are found on the Pennines, sometimes in considerable quantity. In all cases where flints have been found,* they have been found beneath the peat, in or beneath the hard layer of moor-pan † upon which the peat rests (Fig. 5).

In some localities, such as the Fen district,‡ but not on the Pennines, the peat is found buried under recent deposits such as boulder clay. Such peat is, of course, much older than the superficial peat of the Pennines. Where glacial clay is found on the Pennines, as on Rumbould's moor, Ilkley, the peat invariably lies over it; and then its post-glacial origin cannot be doubted.

The essential condition of peat-formation is that vegetable remains shall be laid down at a rate exceeding that of their decomposition. As a rule, the agents of decomposition keep abreast of the formation of dead organic matter. The chief agents of decomposition are anaërobic bacteria; but ferments, moulds, yeast, and the larger fungi also play a part. Many animals, *e.g.* earthworms, insects and insect larvæ, snails and slugs, are also factors in decomposition; but in the Pennine peat all these are in some cases rare, in others absent. Physical and chemical agencies are also concerned. In general, the warmer the climate the less the likelihood of the accumulation of peat; for although more vegetable remains are laid down in the warmer regions, yet there the general conditions of life are such as favour the healthy growth and rapid reproduction of those organisms which bring about organic decomposition. Hence peat, though not unknown,§ is rare in tropical and sub-tropical districts. In the colder countries, on the other hand, although as a rule plant-remains are laid down more slowly, yet peat frequently accumulates; because here the general life-conditions are less favourable. Bacteria are found on the surface of the peat, but not as a rule in the lower layers. The process of peat-formation, once begun, proceeds with accumulative rapidity, owing to the preservative properties of the peaty acids formed by the partial decomposition of dead vegetable matter. Could these antiseptic acids drain away, then bacteria would invade the lower layers: the accumulation of peat would be arrested; and the peat already formed would eventually disappear. When, on the contrary, these acids are unable to drain away, there accumulates that partially but not totally decomposed vegetable matter called peat. Any circumstances, then, which hinder drainage and produce stagnation, assist in the formation of peat. Some such circumstances are the inward growth of the marginal plants of a pond or slow-flowing stream, the damming of springs either by earth or by the growth of marsh-plants, the annual decay of grasses and sedges and plants growing with them on poor soils, the flooding of a district, and the sudden destruction of woodland. An impervious soil, a high annual rainfall, and, in hilly and mountainous districts, the excessive amount of clouds and mists with the consequent diminution of bright sunshine, are conditions which favour the growth of those plants which live in and extend the area of stagnant places, and are therefore factors in peat-

* See *Halifax Naturalist*, ii. and vii.; and *Proc. Yorks. Geol. and Polyt. Soc.*, N.S., viii.

† See an article by Dr. Wm. G. Smith in *Scot. Geogr. Jour.*, November, 1892.

‡ See the *Naturalist*, 545, "Fenland Soils," by Rev. E. A. Woodruffe Peacock.

§ Lyell ('Principles of Geology') records peat from the valleys of the Ganges and the Po. The Black Swamp of Virginia is also peaty, and was once wooded.

formation. As, in settled and civilized districts, stagnation on a large scale is not allowed to recur, it is only possible at the present day to witness the formation of peat on a small scale.

Take the case of a pond. The surface of a pond may be covered with the broad, flat leaves of rootless (e.g. *Hydrocharis Morsus-ranæ*) or rooted (e.g. *Nymphæa lutea*) aquatic plants. Beneath the surface may be a number of rooted, submerged aquatics (e.g. *Ceratophyllum demersum*). All these die down annually, and slowly a layer of peat accumulates at the bottom of the pond. Such peat is mixed with silt; and this, if there be an inflowing stream, may be considerable. The edge of the pond may be occupied with well-rooted plants, with thick, horizontal, perennial rootstocks, and tall, elongated, annual leaves (e.g. *Typha latifolia*). Here the peat accumulates more rapidly; and the process is again materially assisted by the accumulation of mud among the submerged parts. Some aquatic mosses (e.g. *Sphagnum* spp. and *Hypnum fluitans*) are almost sure to occur; and these eventually may take entire possession of the surface, when the final disappearance of the pond is merely a matter of time. Plants (e.g. *Eriophorum angustifolium*) characteristic of wet peat-bogs may now appear; and in this way a small hollow may become filled with peat.* In a similar way, peat may accumulate in lowland districts on the banks of slow-flowing rivers. It has been said that clear water is necessary to peat-formation; but in the colliery districts of Yorkshire and Lancashire, the above process seems to be proceeding where the land, owing to the undermining operations of the colliers, is subsiding, and where the water is by no means pure. This case of the pond, however, is not suited to furnish a parallel to the formation of peat on extensive and irregular summit-plateaux, such as are found on the surface of the Pennines. It is inconceivable that these hilltops could furnish a series of lakes approaching in size the existing Pennine peat moors. One of these stretches southwards from Todmorden for nearly 25 miles:† its breadth varies from nearly 2 to 10 miles, and its altitude from 950 to 2000 feet. There are several such peat areas north of Todmorden, some smaller, some larger. It is not asserted that the formation of peat, as seen in a pond or on river-side banks, does not ever illustrate peat-formation on a large scale. On the contrary, it seems likely that some lowland peat moors—such, for example, as the one in mid-Somerset, where the surface is flat, and where the altitude varies only from 10 to 20 feet—have originated in some such way.

To account for the great amount of stagnation necessary to prelude the formation of the extensive peat moors on the irregular Pennine summit-plateaux, the rapid destruction of extensive woods seems the only possible cause. That extensive primitive Pennine woods existed may now be taken as proved. Their destruction may have been brought about by fire, by the axe, by gales, by decay due to impoverishment of the soil, or by a combination of these causes; and there are many indications that the Romans were at least partially responsible.‡ That the

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* For a graphic account of "Water-plants as Land-winners," by A. H. Pawson, see the *Naturalist*, No. 511.

† 1 mile=1·61 kilometres.

‡ In the discussion which followed the reading of the paper, it was suggested that possibly William I. had had some hand in destroying the primitive Pennine forest. This seems reasonable, so far as the Pennine slopes are concerned; but it has been already shown that the summits were morasses so early as even Saxon and Danish times. Edward I. in Wales, Henry II. in Ireland, John, Duke of Lancaster, in the Border country, and Robert the Bruce in Scotland have all been credited with much destruction of timber.

sudden destruction of growing timber does bring about stagnation, by the interference of drainage by the fallen logs too numerous to be immediately carried away and too green to be wholly burnt, admits of little doubt. In fact, the process has often been observed.* The general process would be accelerated by the fact that on the Pennine summit-plateaux many streams would be stopped near their sources; and numerous and extensive swamps, over the more level regions, would soon be brought into existence. Bog-forming mosses, which are numerous to begin with in upland woods, would easily take possession of the morass, and the normal terrestrial carpet vegetation would be overwhelmed. Such places would act as centres from which marshes would radiate in all directions, even over areas not quite so flat. It is a point of importance that, assuming the destruction of the primitive Pennine forest in Roman times, it is to be expected that the region would be covered with extensive morasses in Saxon and Danish times; and it is only on some such hypothesis that the abundance of the place-name "moss" can be accounted for. It is not necessary to assume that the primitive forest was co-extensive with the hills. There were, possibly, treeless regions on the Pennines, even in Roman and British times, especially on and around the exposed summit ridges. The morasses, formed in the fallen woods below and surrounding these places, would gradually spread over the treeless parts, and eventually the whole summit would be in the same stagnant, ill-drained, and swampy condition. It is this circumstance, I think, which furnishes a further † explanation as to why some of the higher parts of the peat moors furnish little or no buried timber. The accumulation of the dead and only partially decomposed stems of the aquatic mosses would, after a time, partially solidify the morass: upland peat-marsh plants (e.g. *Eriophorum angustifolium*, *Vaccinium Oxycoccus*) would begin to establish themselves; and solidification would proceed still further. Such peat plants as prefer compacter peat (*Eriophorum vaginatum*, *Calluna Erica*, *Vaccinium Myrtillus*, *Empetrum nigrum*, *Erica* spp.) would next get hold; and, finally, peat bogs approximating in condition to the present-day peat moors would be formed.‡ There can, I think, be little doubt that the Pennine peat moors have approximately been in their present condition for centuries. It is noteworthy that many plants found to-day in lowland peat bogs do not occur on the upland Pennine peat moors; neither are the remains of such plants (e.g. *Typha*, *Iris*, *Sparganium*, *Cladium*, *Carex Pseudo-cyperus*) found in the Pennine peat; so that a stage frequently observed in lowland peat bogs, even in those of Yorkshire and Lancashire, has probably been altogether omitted in the case of the peat moors of the Pennines.

The question arises, how is it that the destruction of the primitive Pennine woodlands gave rise to morasses§ on the summits, but not on the slopes? The reason is that the excessive steepness of the lower slopes would not allow of the collection of stagnant water sufficient to permit of the formation of morasses on any but the

* See p. 668.

† See p. 662.

‡ The minute structure of moorland plants is dealt with by Prof. Miall, F.R.S., in "A Yorkshire Moor," *Nature*, vol. lviii., 1898.

§ "After the trees were cut doune, soggith yerth and moss coverid them, and now the same yearth parid away for turvee, the old manye roots appere. . . . The causes be these, first the wood cutt down was never coppised, and this has been a great cause of destruction of wood through Wales. Secondly, after cutting doun of woodys, the gottys hath so bitten the young spring, that it never grew but lyke shrubbes. Thirddely, men for the nonys destroyed the great woddis, that thei should not harborow theves."—Leland (referring to the Welsh coast), 'Itinerary,' v. p. 13 (1710–1769).

smallest scale. Hence on the slopes the primitive forest, even if largely destroyed, would rejuvenate; so that, while on the summits morasses would be in existence in Saxon and Danish times, at the same period the slopes would be covered with rejuvenated woodland (Fig. 7). I believe it will be found, on inquiry, that the lowland surface peat mosses (*e.g.* Chatmoss, Lancashire) on the plains on each side of the Pennines have originated at the same time and in the same way as those on the Pennine summits.

The case of peat-formation on many of the Millstone-grit rocks * which emerge from the surface of the peat deserves consideration, as, though it only occurs on a

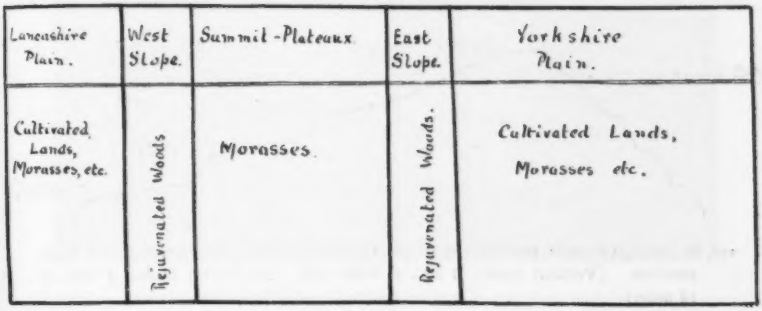

FIG. 7.—DIAGRAM TO SHOW THE POSSIBLE CONDITION OF THE PENNINES IN SAXON AND DANISH TIMES.

small scale, it may be observed in actual operation to-day, and proves that peat may sometimes be formed with no pre-existing pond or swamp. A layer of slimy blue-green or green algæ, or of small lichens, or a layer of both of these combined, forms a layer or moor-pan, and seems to furnish the first stage. Such a layer may increase in depth perceptibly in a year's time. On this layer mosses become established. These mosses are of those species that inhabit dry and exposed localities. They grow rapidly in an upward direction, and form a layer of peat very quickly. On this peat seedlings of plants inhabiting dry peat begin to grow; and eventually a moderate depth of peat, quite detached from the general mass of peat, and formed *in situ*, may be found on the exposed rock. In some cases similar patches of peat seem to be wind-borne; but such blown peat may usually be distinguished from peat formed *in situ* by the absence at its base of the layer of moor-pan. An examination of a large number of such rocks yields so many intermediate stages as to warrant the belief that peat is actually forming in such places at the present time.

Although the term "summit-plateaux" has in the preceding pages been frequently used, it must not be thought that the tops of the Pennines are of the nature of a dead level. As a matter of fact, the altitude may in a few miles change from 1000 to 2000 feet, and yet all the intervening ground be peat-clad. What actually occurs may be inferred from the accompanying diagram (Fig. 8). Ascending the hills, the last of the natural woods is left behind at about 900 or

* These emerging rocks are quite a feature of the Pennine moors. They have their popular names, *e.g.* Buckstones, Doestones, Ladstone, Bridestones, Wheelstones; and are popularly, though perhaps erroneously, thought to have been used as Druidical places of worship and sacrifice.

1000 feet. Then comes a slightly sloping shelf of ground, with a shallow subsoil over Millstone-grit rock, occupied either by moorland farms or rough heaths over shallow peat (Fig. 3). This traversed, a more or less precipitous edge (Fig. 4) is revealed, clothed with heathy grasses or bracken, and which leads up to another shelf of flattish ground tenanted by cotton-grass on deep peat. This is rarely less than 1250 feet in altitude. There may be one, two, or three such edges and shelves to traverse before the final summit-ridge is reached. The declivities consist of Millstone-grit and Yoredale shales, but may be strewn with boulders which have tumbled from the Millstone-grit rocks above. In the latter case the plants are found to be such as the bilberry (*Vaccinium Myrtillus*), the cowberry

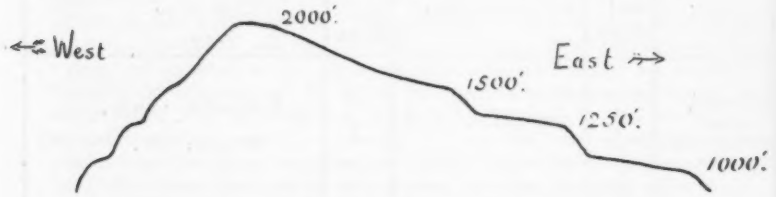

FIG. 8.—DIAGRAMMATIC SECTION THROUGH PENNINE SUMMIT IN LATITUDE OF MANCHESTER. (Vertical scale: 1 inch = 1000 feet. Horizontal scale: 1 inch = 1½ mile.)

(*V. Vitis-Idæa*), and the silver hair-grass (*Deschampsia flexuosa*). The summit-ridges are tenanted largely by the bilberry (Fig. 9). The summit-plateaux referred to are these slightly sloping shelves* of moorland, and are interrupted here and there by rapid moorland streams, which form narrow and deep valleys (Fig. 5). It will thus be seen that the formation of peat by the filling up of hollows is a method inapplicable in the case of the alternating, steep edges and slightly sloping plateaux of the Pennine summits.

Whenever peat is formed in the manner indicated as probable on the Pennine summits, *i.e.* by the conversion of woodland into morasses, and the gradual solidification of the latter by the accumulation of partially decomposed plant remains, it is formed at a relatively rapid rate. Dr. Plot † states that a wood which was felled during the Civil War, having been neglected by reason of the war, was half overgrown with moss in six years' time. The Earl of Cromarty ‡ noted a dead wood in 1651. Fifteen years later he revisited the spot, and found it covered with green moss which took him up to his arm-pits. Steele § alleges that bog-moss (*Sphagnum*) has been known to grow 4 feet upwards in a single year; that *Hypnum fluitans*, a moss which in many districts takes the place of *Sphagnum* in bog-forming, has been known to grow 3 feet in length in a year, and to form a substratum of peat in twenty years; and that *Polytrichum*, another moss which forms peat in dry localities, has been known to grow 3 feet upwards in a year's time. Though such growth of mosses may be regarded as exceptional, if not excessive, yet it will not be denied that the annual increase of peat-forming mosses

* Note the place-name "Shelf Moss."
† V. a., p. 221, Plot's 'Staffordshire.'
‡ *Phil. Trans.*, No. xxvii.
§ V. a., p. 14, Steele's 'Peat-moss.'

FIG. 9.—RIDGE-SUMMIT. THE VEGETATION IS CHIEFLY BILBERRY.

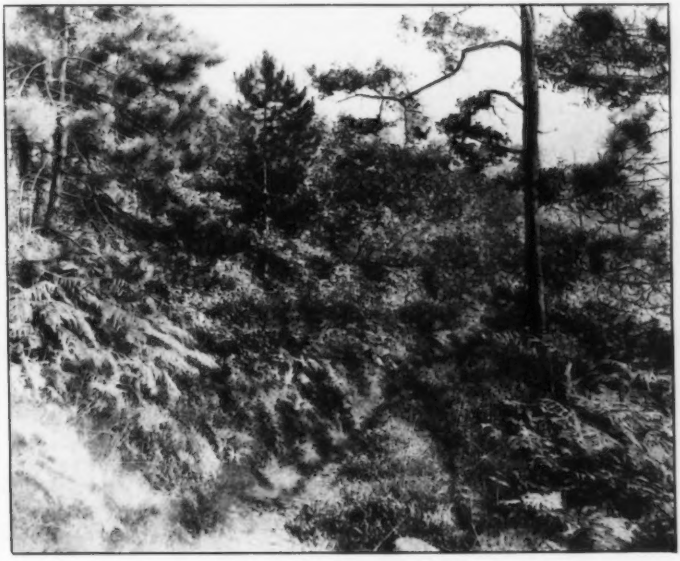

FIG. 10.—UPLAND WOOD. HEATHER AND BILBERRY GROWING ON PEAT FORMED IN THE WOOD. THE TREES ARE OAK AND BIRCH (INDIGENOUS), AND SCOTS PINE (NOT INDIGENOUS).

growing under favourable circumstances is often very considerable. M. Larbalétrier * says that, according to M. Lencauchez, nature produced 60 cms. (23·6 inches) of made peat in a hundred years, whilst in thirty years a peat bog was found filled with aquatic *débris*. The Rev. E. A. Woodruffe Peacock,† speaking of the upper or modern bed of Fenland peat, says it contains late flint implements and signs of Roman occupation, and may date back for 100 or 2500 years, but can hardly be earlier. Prof. Johnson‡ states that in some cases peat bogs increase in thickness each year 5 or 6 inches,§ in some cases not at all. Taking as a fair sample a Pennine peat bed 7½ feet in thickness, and allowing its age to be 1800 years, then the average annual increase in thickness is only one-twentieth of an inch; and in this connection it must be borne in mind that in the earlier years of the history of a deep peat bed the increase in thickness is much greater than in its later years.

Peat, however, even over extensive areas, does not necessarily accumulate at the rapid rate which probably occurred in regard to the deep peat on the cotton-grass moors of the Pennines. On many edges of these moors, carpeted with either dwarf heather or with dwarf heather and heathy grasses combined, the peat is quite shallow—often only a few inches or less in thickness. It is unlikely that a previous morass existed in such places. Remains of *Sphagnum*, which are remarkably persistent, are rarely found in such peat, and even then only in small patches. Such peat seems to be made up of the remains of those plants which still abound on dry heaths. No very great amount of stagnation appears to be necessary to account for the slow formation of shallow peat, but only so much as may be seen at any time in any badly drained pasture. The accumulation of this shallow peat seems to have been preceded by the formation of moor-pan, which furnishes an impervious layer on which heath plants can successfully hold their own. The formation of moor-pan seems to be initiated by the growth of slimy algæ, of lichens, of small liverworts (e.g. *Lepidozia reptans*), and of small mosses (e.g. *Tetraphis pellucida*, *Webera nutans*) on the bare earth, and at the bases of the stems of the larger plants. This stage may frequently be observed, not only on present-day heaths, but also in derelict moorland pastures. Over the remains of the pan-forming plants the creeping stems of heath plants spread; and seedlings of the shrubby heath plants, also begin to grow. Some of the larger peat-forming mosses (e.g. *Polytrichum* spp., *Dicranum Scoparium*, *Campylopus flexuosus*, *Leucobryum glaucum*) may precede the appearance of the shrubby heath plants; and these mosses form a substratum of peat at a relatively rapid rate. These cases may be observed, not only on heaths and heathy pastures, but in rocky, upland woods (Fig. 10). If the ground is damp, heath plants (e.g. *Nardus*, *Molinia*, *Juncus conglomeratus*) with tufted habits may obtain possession. This tufted habit interferes with good drainage, increases the amount of stagnation, and further assists the accumulation of peat; and the appearance of heather (*Calluna*) and the true heaths (*Erica Tetralix* and *E. cinerea*) is almost inevitable. Even those moorland plants of sward-like habit (e.g. *Festuca ovina*, *Galium saxatile*) may, as dependent plants, grow along with the heaths, or themselves cover large areas on the steeper declivities. In the latter places, however, the accumulation of peat is imperceptible, partly because it is washed away as it is formed. The paradoxical conclusion is thus reached

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* V. a., p. 18, Larbalétrier's 'La Tourbe.'

† V. a., p. 181, Peacock.

‡ See *Econ. Proc. Roy. Dub. Soc.*, vol. i. part i., 1889, "The Irish Peat Question," by Prof. Johnson, D.SC., F.L.S.

§ 6 inches = 0·1524 metre.

that deep peat, especially in its early history, accumulates rapidly, while shallow peat accumulates slowly; and there is no reason to think that the shallow peat on the edges of the cotton-grass moors is of more recent origin than the deep peat of the central moorland mass.

At the present time, the peat on the Pennines is not increasing in area; nor is it likely that it has increased in area for many centuries. The upland farms (Fig. 3) are chiefly given over to dairy farming; and the system of small holdings effectually prevents the moorland gaining on the farmland. In some places, however, derelict farms abound; and on these the vegetation becomes more and more heathy as time goes on. On the other hand, it seems certain that much of the heath land could profitably be reclaimed. Neither at this date is the peat increasing greatly in thickness; though wherever the single-headed cotton-grass (*Eriophorum vaginatum*) is dominant (Fig. 1), some increase must be taking place. This increase would, I think, be quite perceptible after the lapse of a few decades were careful measurements undertaken. Probably this species of cotton-grass forms peat to-day more rapidly, and, so far as England is concerned, over larger areas, than any other flowering plant. The increase per annum in thickness over those areas dominated by heather and bilberry is probably very much smaller; whilst over those areas dominated by heathy grasses the increase is probably so small that centuries would be required before any measurable change could be noted. In some places, not only does the peat not increase in thickness, but it even seems to be in a state of physical decay. Such places occur usually on the moors at their highest elevations, when these are flattish for a considerable extent. One such spot, observed at Black Hill, Holme Moss, was almost void of vegetation for fully a quarter of a square mile. A similar state of affairs has also been observed * at Kinderscout, Derbyshire. Such places are covered with deep black peat, which is powdery in very dry weather, and very sodden in wet weather. Drearier spots than these can scarcely be imagined. They are indeed abominations of desolation.

Summarizing, then, I find that the peat moors of the Pennines have originated in morasses formed probably by the destruction of primitive Pennine woods, which in their prime were not only much more extensive, but ascended to a much higher elevation, than their present meagre remains; that in age they are post-glacial, of later date than the Britons, of earlier date than the Saxons and Danes, and probably date from the Roman conquest, and cannot be considered older than 2000 years; and that the shallow peat on the moor-edges is not of more recent date than the deep peat of the central cotton-grass moors.

The Pennine peat moors represent a valuable English asset which is turned to little account. Grouse are driven and shot over them, it is true; but even as shooting-grounds their value would be considerably enhanced by a better cultivation of the heather and bilberry, which plants are better adapted to the habits of the grouse than are the cotton-grasses, and which former plants, by suitable cultivation, could be made to occupy much of the ground now tenanted by the latter. Of late years, too, town and city corporations have utilized the peat moors as gathering-grounds for reservoirs (Figs. 11 and 12). Still, it can scarcely be affirmed that the most is made of the hundreds of thousands of acres of the Pennine moors. There is not a single peat factory (to my knowledge) on the whole of the Pennine chain. Formerly the inhabitants of the moor-edges possessed turf-cutting rights; but these in nearly all cases seem to have been lost. Not only is there enormous value in products manufactured from peat; but there is fuel enough in the Pennine peat to

* See 'British Mosses,' by Sir E. Fry.

FIG. 11.—RESERVOIR AMONG THE MOORS.

FIG. 12.—RESERVOIR AMONG THE MOORS. NEARER VIEW.

last the whole hillside population for a thousand years. Again, the grassy and heathy moor-edges are fit, with a small amount of preparation, to be either at once re-afforested or turned into farmland; and as the peat is gradually cleared from the higher altitudes, as to some extent it is sure to be cleared in the near future, the surface thus laid bare could be similarly given over to the farmer or the forester. In these days, when a shortage of timber seems to be the precursor of a timber famine, which will be felt, and felt seriously, in less than half a century by the whole civilized world, the question of the afforestation of waste lands is one that will more and more engage the attention of practical men; and I confidently expect that succeeding generations will undoubtedly see, what the Britons and the Romans in their times saw, the Pennine hills clothed with trees.

REVIEWS.

EUROPE.

Sketches in Sussex.

'Highways and Byways in Sussex.' By E. V. Lucas, with Illustrations by Frederick L. Griggs. Macmillan & Co. 1904. Pp. xx., 424. With a Map.

The "Highways and Byways" series do not court scientific criticism, unless it were along lines of broad character. They are written primarily with a single eye to picturesqueness, but in the present volume Mr. Lucas has rather happily singled out a special line. "There are, I have noticed," he writes in the preface, "fewer books than there should be upon Sussex men and women." Therefore, while he leaves physical description very largely to his admirable illustrator, Mr. Griggs, he enters quite deeply into discussions of the character, dialect, and so forth, of the natives of his county, exemplifying statement with many a quaint quotation and anecdote, none more quaint than the section of the "Song of Solomon," done into Sussex speech. "Lookee, you be purty, my love . . . You've got dove's eyes adin yer locks." And again, "Till de dee break, and der shadders goo away, I'll git me to de mountain of myrhh . . . ;" certainly a pleasant application of a valuable line of study. Mr. Lucas's work might almost justify the existence of the term "anthropogeography"—through the medium of the Song of Solomon.

O. J. R. H.

ASIA.

Political Problems of Asia.

'The Middle Eastern Question.' By Valentine Chirol. London: John Murray. 1903. Pp. xiv., 572. With three Maps.

Mr. Chirol, who speaks with authority on things Eastern, discusses in the present volume the policy of patient advance followed out step by step by Russia in circum-Indian lands. Mr. Chirol's doctrine is that Imperial statecraft should not confine itself within the shores of the peninsula and the crest-line of the Himalaya. Therefore he opens upon Persia, showing the extent of Russian influence. Persia is the main theme, but the author passes in swift review the Himalayan boundaries of the Empire, and displays Russia's southward gaze across Afghanistan from Khushk, and her patient steps in the direction of Tibet, correlated with the northward movement of France. Afghanistan and Tibet could not be treated as Persia

is treated here; they are strong enough as yet (with Nature's assistance) to guard their own secrets. But it is to be hoped that Mr. Chirol will pursue the whole matter further, for its treatment in the present work is avowedly disproportionate.

There is here admirable descriptive work incidentally, as in pointing the transition from occidental progress at Baku to oriental effeteness at Enzeli and Resht; on parts of Persia, on the Khaibar, and elsewhere. The illustrations, though in no way essential to the text, are effective; of the maps, the coloured one is acknowledged from this Society, the others are diagrams of little worth. A valuable appendix quotes treaties and official correspondence.

O. J. R. H.

Russia in Eastern Asia.

'The Russian Advance.' By Albert J. Beveridge. With two Maps. Harper & Brothers, London and New York. 1903. Pp. v., 486.

In this well-written study of the Far Eastern situation (for it is to the Far East that the author's attention is entirely directed) we have not only an account of 'Russia on the Pacific,' 'Russian Empire-building in Manchuria,' and 'Manchurian Railway Results and Methods,' but also a careful consideration of the position from the Japanese and American points of view, and a detailed view of recent German progress. The last item strikes one as particularly well done. Only two powers, Mr. Beveridge concludes (pp. 152, 153, etc.), are making substantial headway in China, as evidenced by "physical accomplishment on the ground," by "permanent results which you can see with your eye, upon which you can put your finger." These two powers are Russia and Germany. In the summer of 1901 the increase in the "externalization" of German influence would not have been believed but for actual sight and hearing and the "testimony of that sum of physical senses which is expressed by saying, 'it is in the air,' for all over China Germany is in the air." An interesting and useful first-hand account is given of the German enterprise at Kiau-Chau and throughout Shan-tung, as well as of the Russian enterprise at Port Arthur and Dalnii and throughout Manchuria. In contrast to the systematic energy shown by these two nations in recent phases of Chinese history and mercantile development, Mr. Beveridge contrasts American happy-go-luckiness, and complains that, great as are the recent advances of United States commerce in the Celestial world, they are poor and inadequate in comparison with what might be achieved by the incomparable resources and adaptability of his fellow-citizens. On British Far East sluggishness, as he regards it, our author makes severe reflections, sometimes beyond what the facts warrant, but in the main not without justification. In his chapters on High and Low Water-marks of Siberian Progress; Siberia, the Highway of Russian Advance; Russian Capital and Labour, Working-men and Labour Laws, Recent Industrial Progress and National Ideas, Common Schools and Country Hospitals, Mr. Beveridge has put together, with a suggestiveness and lucidity fully as great as may be observed in his treatment of Chinese trade, a long series of valuable observations made on the spot by a man of exceptional insight. The nucleus of the work was formed by articles published in the Philadelphia *Saturday Evening Post* on the author's return from his journeys in Manchuria, China, and Siberia; and it would indeed be difficult to name a more sagacious, impartial, and interesting study of the subject with which it deals. Two matters of regret cannot be passed by: there is no index, and the two maps are unworthy of the book they illustrate. In the second, whose purpose is apparently a comparison of size between the Russian dominions and the rest of Europe and Asia, Mercator's

projection has been employed, with results naturally destructive to the author's purpose. When Novaya Zemlya has to figure equal to New Guinea and Sumatra together, reliable deductions as to area are not easy.

C. Raymond Beazley.

AMERICA.

A North American Medley.

'The Great North-West and the Great Lake Region of North America.' By Paul Fountain. Longmans, Green, and Co. 1904. Pp. viii., 355.

Almost Mr. Fountain seems to have been persuaded to become a scientist, as he unquestionably is a most accurate and lucid observer. He is not a dozen pages deep in his narrative ere he rails against the "confusion engendered by scientific nomenclature," and later he asks for evidence as to why deep lakes do not freeze. Yet it is to be noticed that he gives scientific names in all passages (and they are numerous) which will interest the naturalist, presumably out of consideration for those poor students less fortunately gifted than himself with opportunities of actual observation. In the preface he admits that his work is "retrospective in point of time;" but in a few details it is unfortunately retrospective also in point of fact. This, however, is merely of a piece with the spirit of independence visible all through the author's work, the same which makes him persist, perhaps unnecessarily, in the use of the correct native name Alempigon, in place of the familiar corruption Nipigon. It speaks at once for Mr. Fountain's ability as a writer, and for his breadth of experience, that he should be equally readable on the subjects of the hibernation of bears and of the Shakers of Lebanon, Mass. He maintains, in effect, the reputation, established by his two previous books, which with the present work comprise a series, of presenting a vivid picture of the wilderness he loves, and contrasting it with the advance of humanity from which he would fain escape. The continuation of that advance in the great North-West will heighten the value of his recollections of its virginity.

O. J. R. H.

Maltreated History.

'Hernando de Soto.' By R. B. Cunninghame Graham. Heinemann. 1903. Pp. xvi., 277.

To a writer who is enthusiastic upon an interesting subject something can be forgiven. That forgiveness must be accorded to Mr. Graham, for, frankly, neither his treatment nor his style can be called illuminating. Of his hero he writes, "Born between 1496 and 1500, the conquest of America was going on throughout his childhood." It is to be presumed that this sentence so far defies grammar as to refer to Soto; but the margin allowed is rather needlessly wide, when in 1532 the author sets down his subject as "apparently not more than two or three-and-thirty." A historian might reasonably ask for a statement of the grounds for assigning such dates to Soto's birth, in place of nearly three pages of discussion as to whether, on approaching the Inca Atahualpa as ambassador, he "stopped his horse just at the Inca's chair, its hoofs cutting into the grass as a sharp skate cuts into ice; or whether he wheeled gracefully a few feet off," and so on. Again, an attempt (which is not made) to unravel the chaotic geography of the chroniclers, would probably be at least of greater value than historical criticism by innuendo, such as this—"Five wretched Indians . . . they lanced with as slight compunction as a colonist in 'Fraudesia Magna' would kill a Matabele;" or again, than moralizing such as this—"one of these interludes . . . which, if but comprehended in

the right way (with faith), are part of history, giving a colour of reality even to solid facts." The last seventy pages of the book are a separate essay on Soto's general, Gonçalo Silvestre. O. J. R. H.

TWO BOOKS ON THE HISTORICAL GEOGRAPHY OF THE UNITED STATES.

'Geographic Influences in American History.' By Albert Perry Brigham. Boston U.S.A.: Ginn & Co. 1903.

'American History and its Geographic Conditions.' By Ellen Churchill Semple. Boston and New York: Houghton, Mifflin & Co. 1903.

These two works, appearing almost simultaneously, form very important additions to the library of the geographer and of the historian. The titles of the books give an indication of the difference of their contents. Both necessarily proceed from east to west; but Prof. Brigham's work is divided more according to physical conditions; Miss Semple's more according to historical ones.

Prof. Brigham first takes the reader through the eastern gateway of the Mohawk valley, a chapter reprinted from the *Geographical Journal*; then he leads him northwards to examine the New England highlands, and next southwards to study the Appalachian barrier, looking at both from shore-line to hilltop over to the vast expanses of open land to the west. Here the great lakes first claim his attention, but it is rather their physical story and the effect it has had on present economic development than as old routes for explorers and fur traders that he discusses them. Next, the illimitable prairie country and its almost boundless resources, and the marginal plains producing cotton, rice, and cane, are dealt with, past and present human conditions being more fully described. These chapters are naturally followed by one on the civil war, wherein the opposing economic systems and ideals of north and south came into conflict. The situation and importance of Vicksburg and Chatanooga are most fully treated; the rest is sketched in outline.

From chapter viii. onwards we enter a new territory and almost a new life. The arid areas and irrigation, the mountains, ravines, and forests of the west, are described. The lesson of the need of studying the nature of the resources and conditions of a country and of applying the proper methods of utilizing them is enforced in such stories as that of the settlers of 1885–95, who rushed in, but failed to mark "that vague but stern boundary which separated the regions of ample and deficient rainfall." The boom collapsed; farmers, speculators, and eastern moneylenders alike suffered. An opposition between east and west of some political significance was engendered, which the better methods and prosperity of recent years has greatly weakened. In the region from the Golden Gate to Puget sound, another chapter of American history has been enacted; but it is on the most recent phases that Prof. Brigham dwells longest.

Having thus surveyed his country from east to west, the author discusses the problems of geography and American history, taking as his text Emerson's presentiment that in it "shall laws and institutions exist on some scale proportionate to the majesty of nature." To this chapter we shall return, and for the moment conclude this description of a most excellent and readable series of essays by drawing attention to the last chapter, wherein an account is given of the different "governmental studies of our domain," which we commend to all interested in the improvement of our own country.

Miss Semple has set herself a more difficult task, and attempted to write a systematic work on the historical geography of the United States; and she constantly introduces more general considerations illustrative of the principles of historical geography.

Beginning with the geographical ideas which led to the discovery of North America, she traces the natural lines of colonial expansion in the east, and devotes a chapter to the influence of the rivers on early exploration and settlement. The contrast between French and British expansion is well brought out. Prof. Brigham's view that the victory of the Briton was due, not to "geographic opportunity, but by virtue of qualities inherent in his race," is gratifying to our pride, but is probably much less accurate than Miss Semple's summary that "superficial use of a country's resources always means sparse population, and therefore a weak hold upon the land," and that "the compact settlement of the English made a surer basis for military operations than did the scattered posts of the French."

The influence of the Appalachian barrier upon colonial history is the subject of the chapter, in which events both in the French and English and in the revolutionary wars are discussed. In the struggle for economic and political freedom, the Appalachians were as a wall at the back of the colonial revolutionists. For 150 years they formed a barrier, but once it was crossed, "in half the time it had taken the people to reach the crest of the Alleghenies, they were planting their towns on the genial coasts of the Pacific."

This westward movement is traced first through the Appalachians, and the influence of their configuration on it is brought out. Three important trans-Appalachian settlements existed at the end of the war of independence, corresponding to the gaps east of Pennsylvania, the Kanawha and middle Ohio, and the Cumberland gaps, with a few others all along the great routes. The environment of these young trans-Allegheny settlements—abundance of land, lack of barriers, easy river connection—promoted expansion. The political difficulties—between western and eastern colonists, and the Spanish influence in the south and the British influence in the north—were settled by the freeing of Mississippi navigation and the Louisiana purchase, which is next dealt with "in the light of geographic conditions." The control of the Mississippi was an essential step in the growth of the United States to a great power. It became "the core of the nation as it was of the continent." This did not take place immediately, and the first great expansion was the growth of American sea-power. The length of shore-line, the abundance of harbours, the favourable trade positions and conditions all remain, and the over-sea trade of the United States has grown steadily. But American shipping is not what it once was. One is tempted to ask how far navigation laws and how far facilities for shipbuilding in the days of wooden vessels were responsible for the rapid growth of the American mercantile fleet and its equally remarkable decline. That the natural facilities had much to do with it can be deduced from the comparative unimportance of American international carrying trade in the time of iron and steel built vessels. How far the improved and cheapened transport facilities of recent years and the expanding foreign trade will lead to a growth of a great mercantile marine remains to be seen.

A chapter discusses the naval and land movements in the war of 1812.

From 1830 onwards American energies were directed more to the west, and only with the opening of a new century have they been seriously turned eastwards again. A series of population maps shows clearly the main lines of the new movement across the Mississippi valley; and the chapter discussing the geographical conditions, which guided the main lines of expansion, is followed by one on the southern and one on the northern routes to the far west, and another on the growth of the United States to a continental power, geographically determined.

Of the next five chapters, four deal with special aspects of human geography in the United States—the development of inland waterways and railroads, the

distribution of immigration, the distribution of cities and industries. The fifth treats of the geography of the civil war, and discusses the whole struggle, dealing with the Shenandoah and eastern campaigns at some length, as well as with the Chatanooga and trans-Appalachian struggles.

The concluding chapters are on the United States in relation to the American Mediterranean and as a Pacific ocean power. The utilization of the natural slope of the Mississippi valley to the gulf of Mexico proceeds apace, and gulf ports are growing at the expense of eastern ports as outlets for produce of the plains. New Orleans has outstripped Philadelphia, and may now be bracketed with Baltimore as the second grain port of the United States. The chapter on the Pacific as the "ocean of the future" is a thoughtful one, though in dealing with Alaska Miss Semple falls into the common error of describing Russia as our hereditary enemy, for half a century is too short a period on which to base the term. The Asiatic and Oceanic commerce of the United States more than doubled between 1892 and 1902. Miss Semple rightly points out that the Pacific is unlikely ever to obtain supremacy over the Atlantic as a trade way, and that the exploitation of the Pacific will be from the base of the Atlantic. In any case, America, and this includes Canada as well as the United States, is exceptionally favoured with shores on the two oceans where the opposite lands are richest, and there is some truth, but not the whole truth, in the concluding peroration, "'enthroned between her subject seas,' the United States has the most perfect conditions for attaining pre-eminence in the commerce of the world ocean."

It will be gathered that America in both books is used in the popular and restricted sense of the United States of America, and that as far as the northern continent of the New World is concerned, it is assumed that the United States alone is of moment. No account of the historical geography of North America can be complete without a fuller recognition of Canada, and no forecasts of the future can leave her out of account. Canada, while less continuous and diverse, has such vast, if more limited, economic potentialities, that it must be looked upon as a country which will repeat, a generation or more later, the evolution of the northern parts of the United States, and become the most formidable rival of these northern states. The effect of the spacious west on the ideals and actions of the westerner, so eloquently described by both authors, will also be felt in Canada, which until recent years has been a series of more or less isolated communities with a comparatively narrow outlook.

So much we may foresee from the stories told by Miss Semple and Prof. Brigham. North American history is short compared with that of Europe, and much less complex. The very shortness gives a great simplification to the problems to be dealt with. Its characteristic of human and economic expansion rather than conflict of state with state brings geography and history into the closest connection, and makes the latter seem an almost inevitable consequence of the former.

The complexities of physical and economic conditions, the social and political diversities, and the spacial restrictions of European peoples make European history as fascinating as it is difficult to interpret and to assign to each factor its due proportion of influence. In North America it is different. Miss Semple quotes a sentence from Prof. Ratzel, whose pupil we understand she is, to the effect that "the struggle for existence is a struggle for space." She points out that the "abundant space in the United States has meant abundant opportunity and a chance for all to rise; it has developed in the American a powerful initiative, and encouraged the democratic spirit." She hardly seems to realize how much this upsets the popular conceptions of the struggle for existence as a factor of

progress. The American has had the immense advantage of not having to struggle seriously with his fellow-men for space. He has had only to occupy and utilize it. Even the natural barriers he has had to overcome are comparatively few in the more populated areas. This suggests the need for a more precise statement of the factors making for progress, and a discrimination between the struggle against adverse conditions and the utilization of favourable ones. Nature determines the conditions, and also sets very definite limits to human action. Progress comes from the recognition and study of these. In any given case it is a matter for investigation whether the expenditure on a struggle against unfavourable conditions, such as the building of Mississippi levees or Dutch dykes, will be more than compensated for by the utilization of the favourable conditions thus obtained. Popular philosophy seems to lay all the stress on the struggle against disadvantages. Books like the two under review clearly prove that it is the intelligent utilization of natural resources that is in the end the source of profit and progress.

A. J. H.

CARTOGRAPHY.

Stanford's London Atlas.

'Stanford's London Atlas of Universal Geography.' One hundred and ten maps, with a list of latitudes and longitudes. London: E. Stanford, Long Acre. Third Edition. Imperial Folio. *Price* £12; *for cash with order*, £9.

Stanford's large 'London Atlas of Universal Geography' first appeared in 1887, and by a comparison of the third edition, which has just been published, with this early one, it will be seen that great improvements and alterations have taken place in the work since it first appeared seventeen years ago. Not only are these changes due to the rapid advance in geographical exploration, political events, and modification of boundary-lines, the combined results of which have rendered it necessary to redraw, to a great extent, many of the maps, but no less than twenty entirely new maps have been added, many of which have a direct bearing on events at present occupying public attention. Further, whilst the first edition was generally admitted to be an important work, and contained some good and useful maps, it was, to a considerable extent, composed of maps from plates formerly belonging to the late Mr. J. Arrowsmith, and which appeared in the well-known 'London Atlas' of that eminent cartographer as long ago as 1858; and although attempts had been made to bring these up to date, they were in many cases only partially successful, especially as regards physical features. With the exception of a few, which for some reason have been allowed to remain, these maps have now been superseded, and it is to be hoped that those that still survive will soon disappear. It can hardly be a case of the survival of the fittest, for several of them, at least, such as the maps of Greece and the Ionian islands (No. 51), and China (No. 68), are quite out of character with the rest of the atlas, which on the whole, in its present form, is a most important and valuable collection of good and up-to-date maps. The atlas must perhaps be considered more as a miscellaneous collection of maps than a systematically arranged geographical atlas, prepared according to a definite plan, and with a fixed proportion between the scales, for there is certainly little evidence of any such arrangement; still, there is much to commend, one great advantage being that many of the maps are on quite large scales. Specially is this the case with regard to the British Empire, the maps of which very rightly occupy the chief part of the work, and upon eighty-three out of a total of one hundred and ten maps the British red is shown. Tasmania and New Zealand, however, fare rather badly; for whilst there are no less than five maps

on large scales of the West Indies, it is surprising that only very general small scale maps, on one sheet, are given to these important colonies.

In the revision of the atlas it is evident that great care has been taken with the political geography and boundary demarcation, and it is clear that this work has been placed in thoroughly competent hands; but on some of the maps there is still room for improvement in the physical features, the leading characteristics of which are in several cases not well brought out. An example of this is the map of Switzerland (No. 42), which in many respects is very good, but there is not sufficient relief, and it does not convey at a glance a clear idea of the leading mountain systems.

At the end of the atlas there is a list of places with their latitudes and longitudes, but this would have been far more serviceable if the map upon which the name occurred had been indicated, as it would then have served as an index to the atlas. However, these are matters that could easily be set right, and it is only just to state that this monumental volume deserves a prominent place in the libraries of public institutions, geographers, and politicians, where it cannot fail to be of service for general reference and consultation.

Philip's Mercantile Marine Atlas.

'Philip's Mercantile Marine Atlas.' Specially designed for merchant shippers, exporters, and ocean travellers, and for general use. Edited by George Philip, F.R.G.S. London: G. Philip & Son, Ltd. 1904. *Price* £3 3*s. net.*

Messrs. G. Philip and Son's Mercantile Marine Atlas, which has recently been published, should prove decidedly useful to merchant shippers, exporters, and all ocean travellers, for whom it has been specially designed. In these days of rapid transit there can be no doubt that a work of this kind, carefully prepared from accurate and reliable information, will supply a want felt by many; and in the present case the publishers have evidently sought to make good use of all available material, and have brought together a vast amount of information concerning means of ocean communication throughout the world. The atlas, which measures $19\frac{1}{2} \times 15\frac{1}{2}$ inches, consists of 30 plates containing 100 charts and plans, preceded by letterpress of a general nautical character, including a most useful table of distances between ports for full-powered steam vessels, and followed by an index to places given on the charts. The first 11 plates, several of which are by Mr. E. G. Ravenstein, are occupied by physical charts of the oceans, showing heights and depths, charts showing the visibility of the land, ocean currents, co-tidal lines, winds, magnetic variation, and flags of all nations. These are followed by 19 larger-scale charts and maps, upon which are laid down the tracks of vessels between all important ports, with the distances in miles and days. Upon the land the principal railways connecting the inland towns with the ports are shown, and surrounding the charts are given, as insets, plans of all important ports and harbours. The mail routes are distinguished by red lines, and telegraph cables are clearly marked, and naval and coaling stations, as well as British and American consulates are shown. The larger-scale charts are on Mercator's projection, and are ruled into small squares with the object of facilitating the accurate laying down of additional routes between any points; but this latter arrangement rather tends to confusion, and gives the charts a somewhat overcrowded appearance.

Taken as a whole, this is a most creditable production, and one that cannot fail to be of considerable service.

MATHEMATICAL AND PHYSICAL GEOGRAPHY.

EVOLUTION OF SANDS.

'L'Evolution Comparée des Sables.' By Jules Girard. Rudeval, Paris. 1903.

The subject is divided into four parts, Erosion, Sub-aërial denudation, Sand-dunes, and Coastal changes. The work extends to 121 pages of largest octavo, and is illustrated by 12 full-page plates, three of which are reproductions of photographs, the remainder being maps. There are also 40 smaller figures. The book is a careful compilation from original sources, the references in the text numbering more than 120. It is in the author's treatment of desert sand-dunes that English readers are most likely to find new material, for he has drawn largely upon the excellent records of M. G. Rolland, and other French explorers of the Sahara, which have perhaps attracted less attention in this country than they deserve. A good summary is given of the observations upon the relation of desert sand-dunes to the conservation of moisture, as well as of the effect of moisture in preserving the sand-dunes. The almost stationary character of the greater sand-dunes of the Sahara, which is in such striking contrast to the extreme mobility of the small and *newly formed* sand-dunes, is intimately related to this power of absorbing and retaining moisture. The author says of the great dunes, "Les grandes dunes de l'Erg ne sont mobiles que dans certains cas; suivant la nature du sable, elles offrent une plus ou moins grande stabilité. Dans un ouragan, elles *fument*, au sommet principalement. Cependant, la consequence de la tourmente est insensible, les sables ne sont que superficiellement remués. . . ."

VAUGHAN CORNISH.

THE MONTHLY RECORD.

THE SOCIETY.

The Society and the Eighth International Geographical Congress.—The following have been named by the Council to represent the Society at the approaching meeting of the International Congress: Colonel G. E. Church, Prof. E. J. Garwood, Major Gibbons, Sir Thomas Holdich, Sir Harry Johnston, Dr. Keltie, Mr. Kennelly, Dr. H. R. Mill, Mr. H. W. Trinder, and Colonel C. M. Watson. Particulars as to the programme of the Congress were given in the March number of the *Journal* (p. 393).

EUROPE.

Physical History of the Teign Valley.—This was the subject of a paper read before the Geological Society on March 9 last by Mr. A. J. Jukes-Brown, who pointed out that the Teign valley is noteworthy as consisting of parts of two transverse valleys linked by a longitudinal one, and endeavoured to trace the cause of this circumstance in the history of its development. The beginning of this he dates back to Oligocene times, when the Eocene strata previously deposited over all the central parts of Devon, and banked up against the northern, eastern, and southern sides of Dartmoor, received a general easterly slope from the post-Eocene movement of elevation. The upper Teign valley has a direction consistent with this easterly slope as far as Clifford Bridge, and below this would seem to have continued its easterly course in Oligocene times, instead of turning southward as

at present. The valley of the lower Teign, again, seems to represent the course of a stream (perhaps the ancestor of the present Lemon, or Leman), which rose at a high elevation on Dartmoor, and carved its channel out of the ancient Eocene plain and across the Permian escarpment. It is to the development of this last that Mr. Jukes-Brown attributes the erosion of the present longitudinal valley out of the Palæozoic rocks, the capture of the upper Teign valley resulting in course of time through the cutting back of one of the affluents of the stream which occupied the longitudinal section. To account for this cutting back, he has recourse, perhaps somewhat unnecessarily, to a supposed southerly tilt of the whole region, due to later Earth-movements. As was pointed out in the discussion which followed, the paper is of interest as showing that even in a district composed of ancient rocks, the existing surface features may be of comparatively recent age.

Aunis.—M. P. Camena d'Almeida, Professor of Letters in the University of Bordeaux, has contributed an essay on the historical and regional geography of Aunis to the *Bulletin de Géographie historique et descriptive*. This was the smallest government of France in ancient times. Its boundaries were roughly the Sèvre *niortaise*, the Charente, and its tributary the Boutonne. Marshes, the representatives of the ancient Gulf of Poitou, bounded it to the north, others to the south, and the termination "les-Marais" recalls them in several village names. Isolated hills dotted them, and bear the name of "îles." Eastward lay a great forest; fragments of it survive, and again nomenclature recalls the half-obliterated feature—Breuil, Breuilles, Boisseuil, Saint-Georges du Bois, and the like. To the west lies the Bay of Biscay. A dry, elevated ridge of Jurassic formation, the backbone of the district extends seaward in the Ile de Ré between the mouths of the two main rivers. A calcareous soil ("les groix") is brought down by erosion from this height of land to its foot, and this, with the marshy soil of the valleys, gave Aunis an early reputation as a grain-growing district, while the vine was also cultivated. Along the low coast reclamation was carried on, and a pastoral region was developed. Such development was owing, no doubt, to the impetus to the agricultural industries in a naturally rich district afforded by the natural lines of communication existing between this "région individualisée" and the surrounding districts. From a study of maps, M. d'Almeida carried his list of apposite nomenclature beyond the point already indicated; quoting from Arcère's map, he gives the name of Chère Terre as applied to one inland agricultural tract, and those of Prée aux Bœufs and Saint-Xandre la Fromagère as occurring in the pastoral division of this interesting district.

Geodetic and Cartographic Work in Italy.—In a pamphlet published by the Istituto Geografico Militare, Prof. Attilio Mori gives a detailed *résumé* of Italian surveys from the year 1750, when two priests, Ruggero Boscovich and Christopher Maire, an Englishman, began the measurement of an arc between Rome and Rimini. Their labours were completed in five years, and the mean length of a degree of latitude was found to differ from that obtained by Cassini in France. About ten years later P. Beccaria measured the arcs Mondovi-Turin and Turin-Andrate, and attributed the considerable discrepancy in his mean value to the attraction of the Alps. When these arcs were remeasured by an Austrian and Sardinian Commission in 1821, errors were discovered in Beccaria's astronomical determinations, and the difference between the length of a degree here and in France proved to be still larger than he had stated. In Lombardy important work was done by the astronomers of the Brera observatory in Milan, and the plates of a map of the country, on the scale 1 : 86,400 (the same as that of Cassini), were nearly completed, when the work was interrupted in 1796 by the Napoleonic wars. In the following years various surveys were undertaken by Italian and

French surveyors, notably a triangulation from Turin to Fiume, and one or two maps were issued, among them the first map of Venetia, published at Vienna in 1806. In 1821 the mixed Austrian and Sardinian Commission referred to above connected the French triangulation, extending from Bordeaux to Chambéry, with the series of triangles between Turin and Fiume, and thus a continuous line was completed over 15 degrees of longitude, approximately on the 45th parallel, whereby a marked irregularity in the figure of the Earth was revealed. A map of Piedmont, on the scale 1 : 250,000, appeared in 1841, and in 1845 General della Marmora's map of Sardinia on the same scale. Padre G. Inghirami's map of Tuscany (1830) and the measurement of a base on the Appian Way in 1854–55, by P. Secchi, were also important works. After the union of Italy much greater activity was displayed, and between 1877 and 1895 the whole of the continental part of the kingdom was surveyed by the Istituto Geografico Militare, on the scale 1 : 50,000, and partly on the scale 1 : 25,000. The survey of Sardinia was completed in 1900, and that of the little island of Montecristo in 1902, and the connection of the Sardinian triangulation with that of the continent put the finishing touch to the work. A topographical map was prepared on the scale 1 : 100,000, in 273 sheets; only thirty sheets are now unpublished, and a new edition of a map on the scale 1 : 500,000, first prepared in 1883, has recently been issued.

ASIA.

Prof. Musil's Maps of Ancient Moab and Edom.—Prof. Alois Musil, of Olmütz, presented to the Vienna Academy of Sciences in December last a preliminary report on the map, prepared by him, of the land to the east of the Dead sea, the ancient land of the Moabites. This report we here reproduce in brief. The map comprises the territory from Hirbet Nefa'a, Gebel al-Mashkal, Wadi al-Buttim, Wadi al-Hart on the north to Wadi al-Hsi, Gebel Hjanajem and Wadi l-'Awbeh on the south, and from the Dead sea on the west to Wadi Sirhan on the east. The high plateau of Moab belongs in its greatest extent to the basin of the El-Mojib, which, issuing from a height of 2600 feet, and descending a steep incline, empties itself into the Dead sea 1300 feet below the level of the Mediterranean. El-Mojib receives its waters in the rainy season from five main valleys, which themselves branch out into numerous lateral valleys. The stream flowing by El-Kerak, wrongly named el-Franji, and just as wrongly, in hitherto existing maps, represented as making its passage from the Pilgrims' route (towards Mecca), rises, under the name of Wadi es-Sinine, to the south of el-Kerak; and, flowing to the north of it, then bends, as Sejl es-Sadde, in a north-westerly direction. Extremely remarkable are the kettle-shaped basins of the Wadi el-'Ammal (or Sejl 'Asal) and of the Sejl Rurab (or Gediva). It seems striking that the stream al-Hsi (or el-Kerahi), which cuts a valley 2300 feet deep through the entire breadth, from east to west, of the Moabite plateau, receives itself next to no water from the plateau. The new map gives it twelve lateral valleys, which open into it from the north. They are, however, very short, the longest not more than 5½ miles long. The eastern half of the region shown in the map has an easterly slope, and belongs to the basin of the Wadi Sirhan. The map shows all the essential details of the country, and the heights of many of the peaks have been determined. Musil found considerable signs of mineral wealth, and in one place there was even coal. The hot springs, six of which are reproduced with their names, are no doubt those already known in antiquity (Kallirrhoë). The margin of the desert is marked by ruins, while those on the east and south-east shores of the Dead sea likewise point to a richer population once occupying its banks. Even at the present day the country struck the professor as the fairest and most fruitful ever seen by him. From the richer past remains of

roads are still in a state of preservation. From the frontier ravine, al-Hsi, as many as seven hill tracks were counted, while eight led across the al-Mojil ravine. Numerous were also the ways communicating with the desert. All of them were strongly fortified, and that, too, long before the time of the Romans, who merely utilized the fortifications they found extant. The Roman road connecting Damascus with the Red sea is perfectly recognizable. Of especial interest, however, is a second Roman road, which at Maradd branches off from the first. It leads by way of Mote and Cutrabba to the peninsula of el-Lisan, and thence to the Dead sea. According to credible witnesses, this road, sixty to seventy years ago, cut right across the lake, and only here and there dropped 2 or 3 inches below the surface. In consequence of an earthquake, it is said to have become completely submerged. This passage across the Dead sea was made use of, also, by the Crusaders. The castle Marescalcia, now el-Kerje, would seem to have served as a protection to it. The map will be accompanied by a descriptive text, a synoptical view of all the scholar's travels in the land of Moab, together with photographs, pictures, and plans of landscapes and places. In January last the same traveller gave the academy a preliminary report on a complete map and topographical description of ancient Edom. This region—which Euting of Strassburg has pertinently characterized by the name of Derb el-razawat, *i.e.* way of raids, seeing that here P. Lagrange was robbed and E. H. Palmer murdered—has hitherto remained unmapped. Situated between Palestine and the peninsula of Sinai, it now lies almost completely waste. Yet it once gave passage to the commercial highways between Egypt, Gaza, Phœnicia, and Damascus on one side, and South Arabia, India, and East Africa on the other. It was the seat of a highly developed material and intellectual culture. Now, in the midst of the solitary desert, its forsaken cities still rear aloft their battlements and towers in good preservation, and but partially silted up. The primeval capital of the region was the enigmatic al-'Abde. When the Romans made themselves masters of this domain also, Trojan caused a military road to be constructed thence as far as the Red sea.

Ornithology of South-Western Persia.—The results of an ornithological journey in Fars were communicated by Mr. H. F. Witherby to the *Ibis* for October, 1903. This tour occupied three months from the middle of March in the previous year, and some 800 miles were covered. The avifauna was found to vary according to the physical conditions, and no less strongly. Thus, after ascending the Kotal-i-Dokhtar, a pass over one of the parallel mountain-lines which here lie about north-west and south-east, some 40 miles directly west of Shiraz, a beautiful oak-wooded valley was reached, the trees closely resembling English species, and such familiar birds as nut-hatches, tits, wood-pigeons, jays, and blackbirds appearing; while, when the woods gave way sharply to grassy plains, the bird-life changed as suddenly, and the lark and bunting appeared. There was also, however, a distinction to be observed dependable upon altitude above 5500 feet, increasingly noticeable beyond 6000 feet. Only one bird was found "at all elevations and in every variety of country"—the Chukar (*Caccabis saxatilis chukar*). Mr. Witherby gives a list of 163 birds, adding five which do not find place in the lists of Dr. W. T. Blanford, Mr. W. D. Cumming, and Mr. A. J. V. Palmer, and bringing the total of the known avifauna of the Persian region up to 400 in round numbers. An interesting feature of his collection is the pale coloration of many of the birds, a phenomenon also noticed by Dr. Blanford. Mr. Witherby attributes this to some physical cause, as distinct from any natural protective reason, and supposes "some bleaching quality in the atmosphere of this region." The oak-wood avifauna above indicated was specially noticed by Dr. Blanford, who placed it in a distinct zoological region of Persia, one of five; and this Mr. Witherby supports.

Here the characteristic birds are Palæarctic; on the coast plains this branch appears mixed with the Indian and some North-East African forms, and at the highest altitudes reached by Mr. Witherby, Palæarctic, Indian, and African birds were also noted.

Caspian Sea.—The Russian Ministry of State Domains is this spring sending out a new expedition for the exploration of the Caspian sea, on board the steamer *Geoktepe*. It will be a continuation of the Aral-Caspian expedition, which was at work some thirty years ago (under Grimm), and its special line of research will be the hydro-biological exploration of the sea, as well as the biology of the Caspian herring. MM. N. Knipovitch (the explorer of the Arctic ocean and the White sea), A. Lebedintseff (explorer of the chemistry of the Black sea), N. Borodin, I. Arnold, E. Suvoroff, S. Mitropolsky, A. Henckel (botanist, from the St. Petersburg Society of Naturalists), V. Kononoff, and several local men, will take part in the expedition.

A Winter Journey in the Altai.—A venturesome journey to the snowy peaks of the Bielukha group was made last year by Mr. S. Turner, who gives a brief account of the journey in the February number of the *Alpine Journal*. Travelling quite early in the year, Mr. Turner encountered difficulties not experienced by previous travellers, severe snowstorms being a frequent occurrence, and the thermometer constantly showing many degrees of frost. The journey was made in company with Kalmuk hunters, and the part of the route beyond Biisk was done by eleven stages with sledge and drosky, the longest being 40 miles. Some of the traveller's statements are far too sweeping, as, *e.g.*, that there is no English literature on the subject of the Altai, and only one book in Russian; and that the district visited was known only to peasants and Kalmuks. His spellings of proper names, too, are often inaccurate, *e.g.* Prof. Sapozhnikoff appears throughout as Sopozinikoff. Not being a trained observer, he has not been able to bring back results of scientific value, but some of his observations are of interest in view of the unusual season at which the journey was made. He notes the temperatures observed throughout, though it does not appear to what extent his thermometer could be relied on to give accurate results. He describes the circular valleys in the mountains, the level floors of which are bounded by perpendicular slopes, and notes the conditions of freezing and melting of the rivers. They are, he says frozen to the bottom from November to February, but there is an undercurrent at the end of March, which breaks the ice by the end of April. The glacier-ice struck him as particularly hard by comparison with that in the Alps, and this made the surfaces of the glaciers difficult to traverse. Signs of a considerable recent retreat of the Bielukha glacier were observed.* Mr. Turner claims to have climbed a peak in the Bielukha group with an altitude of 17,800 feet, but this determination, having been made by a single aneroid, must of course be quite untrustworthy. In the absence of a map, the route followed within the mountains cannot be precisely ascertained. The paper is accompanied by two or three good photographs of the Altai peaks.

The Names Manchu and Manchuria.—Events in the Far East have directed some popular attention to the origin of the name Manchuria, as applied to the territory whose ultimate fate depends so largely on the issue of the present war. It is hardly necessary to state that the name as used by us is unknown to the natives themselves, but has been coined by Europeans, after the analogy of other territorial designations, to signify the country of the Manchus. Even as applied to the people, the name is not of great antiquity, for, as stated by Sir R. Douglas

* Russian investigations have shown that all the Altai glaciers were once more extensive (cf. *Journal*, vol. xii. p. 185).

in the 9th edition of the 'Encyclopædia Britannica,' it first came into use in the thirteenth century, when it was adopted by the original founder of the present Chinese dynasty, then ruling in the more northern region. According to this authority, the name chosen by this ruler as the designation of his family, pronounced Manchau by the Chinese, signifies "pure." Other proposed etymologies were quoted by Sir H. Howorth in his paper on the origins of the Manchus in the *Journal of the Royal Asiatic Society* for 1875. According to Klaproth, the Chinese characters representing the name mean a well-peopled island, while Palladius (*J.R.G.S.*, vol. xlii. p. 154) says that the name Mantziun, *i.e.* "Chinese soldiers," was applied to Chinese emigrants settled by Khublai Khan on the borders of Korea, and Sir H. Howorth mentions this as a possible origin of the term Manchu. On the other hand, some have supposed the name, which is transcribed Mandjhau in Tibetan, to be of Tibetan origin; while still another suggestion is that it came from the Korean deity Manchushri, supposed to have his abode in the Long White mountain. According to Palladius, however (*l.c.*, p. 164), the similarity is purely accidental. Mr. R. T. Turley writes stating that the pronunciation of the name by the people themselves is Man-jo, not Manchu, the latter having come into use through the French fathers, who wrote Mantchou. The earlier English writers often wrote Mandshooria, Mandchuria, and Mantchu, while the Russian form is nearly equivalent to Manchu. Mr. Turley also mentions that the name Mukden is unknown in the country, being a corruption of the native form Mu-gu-dun introduced by the Jesuits. Mongol should also, he says, be properly pronounced Mong-gu.

North-Western Mongolia.—The second part of vol. xxxiv. of the *Memoirs* of the Russian Geographical Society for General Geography contains a valuable paper by P. Kryloff, "Travel Notes on the Land of the Uryanhais." The journey was made in 1892 for botanical purposes; but the author carefully noted at the same time the geographical aspect and the geological structure of the country, and made a survey in those portions of it which had not yet been visited by Kryzhin and Bobyr. During all his journey he made barometrical observations, with the aid of two aneroids, one of which seems to have behaved very well, and his account is accompanied by a map, by sketches of his surveys, and by hypsometrical cross-sections. The country he visited is certainly not unknown, but the traveller's notes are quite welcome, nevertheless; and in the eastern portion of his journey Mr. Kryloff visited the less-known valleys, dotted with lakes, of the Iisuk, the upper Hamsara, and the Azas, while in the west he followed the usual route from Minusinsk to the Us, and thence due south to Lake Ubsa-nor. The journey of Mr. Kryloff fully confirms the plateau character of North-Western Mongolia, and shows even the steppe character of the broad open valleys of the main rivers; it gives also some interesting data about the Tannu-ola mountains. All through, one finds in these notes numbers of interesting data concerning the character of the vegetation. The collection of rocks which was brought back by Mr. Kryloff, as well as the collection of D. Klementz brought back from the same region, is described in an appendix by Prof. Zaitseff. Granites, especially granite syenites, quartz porphyries, and porphyrites are the prevailing rocks, with the corresponding gneisses, quartzites, crystalline limestones, and metamorphosed clay-slates and sandstones; some conglomerates—the latter of Devonian age—were found on the Us, and also in the spurs of the Tannu-ola. Some coal-bearing layers of Jurassic age were also found in isolated basins, deposited, in all probability, in sweet-water lakes.

The New Franco-Siamese Treaty.—The convention signed in October, 1902, between France and Siam (*Journal*, vol. xx. p. 653) not having been ratified on account of the opposition of the French Colonial party, a new treaty has been negotiated, and was signed by the representatives of the two countries on

February 13 last. The actual territorial adjustments remain almost as arranged in 1902, the French boundary between the Tonle Sap (great lake) and the Mekong being shifted northward so as to embrace the districts of Melupre and Bassac. The boundary between the Tonle Sap and the sea is, however, to be the subject of further negotiation between the two countries, before being demarcated by a mixed commission; and it is announced that the port of Khrat, on the bay of the same name south-east of Chantabon, will be recognized as French, although the more important position of Chantabon itself, held by France for the last ten years, will at last be evacuated. Siam, on the other hand, formally renounces all rights of suzerainty in the territory of Luang Prabang situated on the right bank of the Mekong, the boundary of which is defined in Art. 2 of the agreement. But the greatest gain to France is in connection with the portion of Siamese territory within the Mekong basin, where French influence will in future be so far recognized as to bring this territory virtually within the category of a protectorate, facilities being granted in particular for the establishment of commercial posts on the right bank of the river, and the development of railways and other means of communication. France also secures exceptionally favourable terms as regards the status of French subjects settled in Siam, who will be virtually placed under French jurisdiction.

Explorations in French Indo-China.—The January number of *La Géographie* contains the summary of a paper read before the Paris Geographical Society by Dr. Bernard, who has spent three years in researches in the central part of French Indo-China. The description is limited to a small area only—a plateau inhabited by the Boloven aborigines, belonging to the Khas group; but the paper is of interest from the forcible picture it presents of the nature of the country and the relation of the people to their surroundings. The plateau (which lies east of the Mekong between 17½° and 18½° N.) rises in a series of terraces from the wide plains which surround it, the lower steps being clothed with luxuriant vegetation, while on the central and highest terrace, 3000 to 4000 feet in altitude, the flora becomes very limited. In ascending from the plains, which have a parched and desolate aspect at the height of the dry season, though verdant during the rains (May to November), the traveller passes through zones of vegetation, the forests consisting in turn of pines, oaks, chestnuts, etc. On the upper plateau the year is divided into three seasons—the dry, from March to June; the rainy, in October and November; and the cool, from November to March. During the last the climate is delightful, the temperature varying from 46° Fahr. at night to 86° in the day; but the excessive heat and great moisture of the other two render them unhealthy. The Boloven Khas are a dolichocephalic race, of small stature, and are great hunters and fishers. Property is, as a rule, held in common, and the village affairs are directed by the assembled heads of families. Their active and warlike character differentiates them sharply from the indolent inhabitants of the plains. While not exactly fitted for a sanatorium, Dr. Bernard thinks that the plateau may in future be of use as a temporary place of refreshment to the French officials and others.

Meteorology of Ceylon.—From the Colonial Office Report for 1902, it appears that the rainfall for that year was from 14 to 30 inches in excess of the average of thirty years. It varied from 167·29 inches on 235 days at Ratnapura to 50·90 inches on 95 days at Hambantota. The mean temperature at Colombo was 81·8° Fahr., and at Kandy 75·4°, the mean daily range at these two places being 12·7° and 15·8° respectively. The hottest station, taking the mean temperature of night and day all the year round, was Mannar (82·3°). The wind varied from an average of 30 miles a day at Ratnapura to 246 miles at Hambantota.

AFRICA.

Conclusion of the Chevalier Mission in the Central Sudan.—M. Chevalier, the earlier stages of whose important expedition to the north of the Congo basin have already been referred to in the *Journal* (vol. xxii. pp. 85, 569), has now returned to France, after continuing his researches in some of the least-known parts of Wadai, Baghirmi, and neighbouring regions (*Rev. Française*, 1904, pp. 111, 179). The most interesting result of these further explorations is the light thrown on the district of Lake Iro, in southern Wadai, which has hitherto been only vaguely known, though the lake has long figured on the map of this region. It occupies the centre of a swampy tract, the inhabitants of which are quasi-amphibious in their habits, and to this character of the district must be ascribed the length of time during which it has remained practically unknown. The people belong to the Gulla (Kulla) stock, which is related to that of Baghirmi. During the wet season the whole area is inundated, and the people constantly move about with the water up to their waists. M. Chevalier also surveyed the lower course of the Bahr Salamat, the principal river of Wadai, and then made his way to Baghirmi by way of Dikakire, the dry bed of an old lake. The district is strewn with granite bosses, pierced by caves, in which a race of small stature has taken up its abode. The stature of these people is said not to exceed 4 feet 7 inches. They live chiefly on the flesh of the buffalo or antelope, which they kill with arrows. According to the later account, the people of the Dikakire district live on the summits of almost inaccessible eminences. The mission met with a friendly reception in Baghirmi, the capital of which is now nothing but a heap of ruins. It afterwards proceeded to Kanem, which seems to be in course of depopulation, the inhabitants constantly migrating to the islands of Lake Chad, where a progressive desiccation is said to be observable. M. Chevalier and his party ascended the Shari in the *Léon Blot*, and made their way home by way of the Congo, reaching Paris after an absence of twenty-two months.

The Region of Lake Kivu.—During the work of the Congo-German boundary commission in the Lake Kivu region, considerable additions were made to our knowledge of the Kirunga volcanoes by the surveys of the experts on either side. After the regretted death of Dr. Lamp, the leader of the German party, the direction of the work devolved on Captain Herrmann, already well known for his observations in various parts of German East Africa, who has lately contributed a sketch of the physical geography of the region to the *Mitt. aus den Deutschen Schutzgebieten* (1904, Part i.). Captain Herrmann had hoped to devote special attention to the geology, but the extra work in other directions involved by Dr. Lamp's death prevented the formation of an extensive collection of specimens, though a certain number were brought home and are reported on in the same number of the *Mitteilungen* by Dr. Finckh of Berlin. Captain Herrmann's general conclusions as to the physical history of the region agree on the whole with those of Mr. J. E. S. Moore, whose work is, however, not alluded to in the paper. At the original formation of the rift-valley a block of mica-schist (which forms, with quartzites, the principal constituent of the walls of the valley) only partially sank below the original level, and thus continued to connect the opposite sides by the diagonal barrier still existing to the south of Kivu. This was much fractured on its south side, and allowed the newer volcanic matter which still characterizes this side to well up from beneath. At this period the site of the present Lake Kivu was either drained to the north to the Albert Edward lake, forming a gently inclined plain divided by an elevated block represented by the modern Kwijwi, or Ijwi, island; or was occupied by a lake forming one body of water with the Albert Edward, which would in this case have stood at a higher level than at present.

Captain Herrmann inclines to the former view, which, it will be remembered, was that of Mr. Moore. The elevation of the existing volcanoes was in any case the cause for the southward diversion of the waters. The latter part of the paper is taken up with a detailed description of the volcanoes, which may be divided into three groups —an eastern, consisting of three extinct volcanoes lying in an east-to-west line; a central, also consisting of three extinct peaks, arranged, however, in a triangle; and a western, formed by the two summits, still in a state of activity. As regards the name of the peaks, it may be noted that the name Sabyin ("toothed") is sometimes applied to one of the central, as well as to one of the eastern peaks. To the highest of all, Karisimbi, Captain Herrmann assigns a height of 14,700 feet, as against the 13,000 of Mr. Moore. His descriptions (which are especially detailed in respect of the two active peaks, both ascended by members of the German commission) are reinforced by sections and photographs. A sketch-map is also given, the large-scale map embodying the results of the survey (1 : 100,000) being not yet ready for issue.

Rainfall of Usambara.—Heft 7 of the *Berichte über Land- und Forstwirtschaft in Deutsch-Ostafrika* consists of a report by Dr. Carl Uhlig on the rainfall of this district. The records have been kept only for a short series of years, and in some cases are defective, but nevertheless they give a general notion of the climate. All the stations in East Usambara, except Magrotto, lie on the plateau of Handeï, in the south-western part, where the most important plantations are situated. The annual fall varies from about 58 inches to 91·4, the latter being the mean for Kwamkoro, about 3100 feet above sea-level. The eastern edge of West Usambara lies at a distance of 50 miles from the coast, and the Handeï lies between, stretching to within 35 miles of the coast. But the elevation of the former district is much greater, and it has been shown that it contains more rainy localities than Kwamkoro. Balangai (4130 feet) had a mean for the three years (1900-2) of 116·4 inches as against 97·2 inches at Kwamkoro during the same period. Kwai, at the back of a deep valley running east-south-east, and at the altitude of 5310 feet, has a yearly mean of only 30·4 inches. It is apparent, then, that Usambara exhibits astonishing variations, considering its small area (East Usambara about 1000 square miles, and West Usambara about 300). There are two maximums, the absolute maximum in May and a secondary in October or November. The soil of Usambara is saturated with moisture from the middle of April, and Dr. Uhlig attributes the May maximum rather to evaporation from the ground than to the south-east trade wind, which does not thoroughly set in until June, and causes another rise in the rainfall in July, which sometimes exceeds the secondary maximum in October, produced by the north-east monsoon. Dr. Uhlig has thoroughly worked out the results and calculated the density in each month, the probability of rain, percentages of monthly fall in terms of the annual, etc. A map showing the situation of the stations with regard to the sea and the configuration of the country would have been a useful addition to his article.

Geological History of Southern Cape Colony.—A recent paper by Mr. A. W. Rogers, printed in the *Transactions* of the South African Philosophical Society (vol. xiv. part 4), throws a valuable light on the past history of the southern part of Cape Colony, though primarily concerned with a single river-system only—that of the Gouritz. It will be remembered that the streams which flow south from the main water-parting in the Nieuwveld and other ranges break through other parallel ranges during their course to the sea, instead of taking the easier direction of the longitudinal valleys between them. The most obvious explanation would be that their courses had been determined previously to the elevation of these ranges, and that the deepening of their valleys had kept pace

with the latter. Mr. Rogers holds, however, that this has not been the case. He shows that the great anticlinal folds of the Zwarteberg and Langeberg ranges, through which the main branches of the Gouritz river at present break their way, were probably in existence before the development of the existing river-system. The "Zwartberg" movements to which these folds were due seem to have taken place some time between the deposition of the upper part of the Beaufort series and the close of the Stormberg stage. The subsequent uplift of a part of the Karroo system gave rise to the southerly drainage from the main watershed, while the deposits of the Uitenhage period (Lower Cretaceous?) buried most of the old surface features to the south, so that, on a subsequent elevation, the rivers ran across the partially buried mountain chains, gradually working their way down to the highly diversified old surface beneath, and with no direct relations to the structure of the country over which they ran. In course of time the Gouritz system was developed by the ordinary processes of river-capture, which account for the abnormal course of the Buffalo river before joining the Gamka to form the Gouritz. Mr. Rogers refers also to traces of an old peneplain in this region, which has been dissected as the result of a new movement of elevation relatively to the ocean.

AMERICA.

Geological Work by Mr. I. C. Russell in Idaho and Oregon.—*Bulletin* No. 217 of the U.S. Geological Survey consists of Mr. I. C. Russell's notes on the geology of South-Western Idaho and South-Eastern Oregon. These are the results of a rapid reconnaissance made during the summer of 1902, in continuation of similar work in Southern Idaho, for the especial purpose of discovering workable artesian basins. In this object the reconnaissance was successful, but the results have already been set forth (Water-Supply and Irrigation Paper, No. 78), and the present treatise is confined to general geological observations only. In the region considered, rainfall is slight and the summers hot, and it comprises the most arid portion of each state. On the lower ground the sagebrush is almost the only vegetation, but two tree lines occur on the mountains at varying heights, the lower marked out by the arid condition of the low lands, the upper or true line by the usual climatic conditions of high elevation. Sometimes the effect of the lower conditions obtains so high as to meet with that of the higher, and an absence of trees results. The most noteworthy tree is the mountain mahogany. The region consists mainly of broad, flat-bottomed valleys separated by abrupt mountains, and formed by their upraising. The principal valley is that of the Snake river, "underlain by lacustral and stream deposits and by extensive sheets of basaltic lava." Tertiary sediments occur principally in South-Western Idaho and the adjacent parts of Oregon, while in Southern Idaho lava-sheets are more noticeable and continuous. Great variety appears in geological detail, and consequently in physical formation, in the valley walls. Of mountains two types occur, the broad, dome-shaped *massif*, such as the Owyhee mountains, and the narrow, sharply ridged range, such as Mahogany mountain and Stein mountain. In these examples the work of erosion is very strongly shown in the igneous rocks and Tertiary sediments of the first, and in the (probably) middle Tertiary basalts of the third, but less so in the hard rhyolitic tuff beds of the second. There are two main divisions of drainage. The part of Idaho under consideration, with Malheur county and the north-eastern portion of Harney county, Oregon, drain to the Snake; but the greater part of Harney county forms part of the internal drainage area of the great basin. The streams are generally intermittent; those of the first drainage area have trenched channels, but those of the

second have not, the valleys being flat and containing lakes, or dry lake-beds, which frequently exhibit saline incrustations, in some cases giving promise of commercial value as containing boracic acid. The soil is rich, and only requires irrigation to render it fertile; its natural covering of succulent bunch grass has been destroyed in recent times by excessive grazing on the free pasture lands belonging to the Government. Hot springs are of frequent occurrence, and are of especial interest as regards their bearing on the possibility of obtaining water by artesian boring. The detailed geological discussion in the bulletin is mainly devoted to the consideration of the trace and work of the numerous recent volcanoes of the region. It concludes with a general synopsis of the geological circumstances under which petroleum may be expected to occur, in view of the fact that several attempts have been made in the region to obtain this oil. These have been unsuccessful, and Mr. Russell is able to suggest only one small locality where petroleum might be sought, with a reasonable expectation, from the scientific point of view, of finding it; and he does not anticipate its existence in such quantity as would be of commercial value. Artesian boring, in his view, is to be the commercial salvation of the region.

Agricultural Statistics in the United States.—One part of Herr T. H. Engelbrecht's 'Geographische Verteilung der Getreidepreise' (Paul Parey, Berlin, 1903), deals with the geographical distribution of the prices of agricultural produce of various kinds in the United States. After a general discussion, a series of tables in the highest detail are provided, dealing with the prices of wheat, rye, barley, oats, maize, buckwheat, potatoes, and hay; giving averages, and considering the relative fall of prices, over terms of years, in each of the several states. These details are finally generalized on to a series of maps, which show, by lines of equal value, the fluctuations of prices over the three periods 1871–80, 1881–90, 1891–1900, of all the commodities named. There is apparent from these, broadly speaking, a general sinking of prices, or rather an extension of the area of cheapest price. Moreover, these maps show, in a most interesting manner, the greater or less extension of cultivated area as regards the several crops; wheat showing, as would be expected, the largest increase of distribution, and maize and buckwheat the smallest.

AUSTRALASIA AND PACIFIC ISLANDS.

Work of the Government Survey in New Zealand.—In the year 1902–3 triangulation work generally lapsed in New Zealand, as the surveyors were under urgent orders to hurry forward with surveys to open land for settlement. The necessity of revision of triangulation as a whole, in order to bring all the minor series into uniformity, was, however, strongly felt. At the request of the Marine Department, the delineation from official land surveys of the coast-line was taken in hand. The initial point is Mount Cook (Te Aro, Wellington), the longitude of which had been altered previously by 51″. The latest Admiralty charts were found to have adopted the former assumption of this longitude, so that to suit the new estimate the meridian lines had to be altered. The coast-line was thereafter replotted from the best settlement surveys. The outline of the Admiralty charts is stated to have been found generally accurate from these tests; though a specimen map provided in the Report of the Department of Lands and Survey (J. W. A. Marchant, Surveyor-General), shows noticeable minor divergences in a portion of the coast of Foveaux strait. Apart from the land-settlement surveys, this was the most important piece of work undertaken.

Niué and its Native Life.—In 1901, after the annexation of several of the Polynesian islands to New Zealand had been declared, Mr. S. Percy Smith,

secretary of the Polynesian Society, availed himself of a temporary position in the Niué as Government Resident to study in detail its physiography, flora, fauna, and more especially its native population. The results were communicated to the *Journal of the Polynesian Society* (vols. xi., xii.), and have been issued in New Zealand in pamphlet form. The name of this island, which lies some 240 miles east of the nearest land (in the Tonga group), is in full Niué-fekai, a form used in native song and story, and on occasions of formality. It is connected with *Niu*, the coco-nut; the introduction of which is by tradition the outcome of an expedition made by two native voyagers from here to Samoa, where they were given two nuts. The island had borne four names ere this. Cook's name of Savage island is disliked by the peaceful natives of the present day, as they think, not without justification, that it unfairly stigmatizes themselves and their fathers, who opposed Cook's landing only through utilitarian motives, and without harming his crew. Mr. Smith traces the original colonization to about the eighth century A.D., from Samoa. Various subsequent communications with the world without appear to have been generally of a hostile nature. The opposition to Cook (1774) was based probably on some previous experience of disease contracted through contact with foreigners. The same disaster occurred on the return of two natives taken from the island by John Williams in 1830, with a view to initiating Christianity. By 1861 subsequent missionaries had been more successful, and in spite of the evil communications of unscrupulous white men, the favourable attitude of the natives towards white authority was established by 1887 when they applied for the protection of Britain. This was effected in 1900. Mr. Smith notes two types of native in Niué, one having unusually developed signs of Melanesian admixture of blood with the Polynesian, this type occurring in the south of the island, but this admixture he dates from before the colonization of the island. The southerners are called Tafiti (as distinct from the Motu), and probably represent a second immigration, subsequent to the coming of the original Motu, from the Fiji group. In this connection it is to be noted that in the native governmental system the chief is elective, not hereditary, as in Tonga and Samoa. The two groups were formerly strongly antagonistic. As regards physical characteristics, the island is purely of coral rock, which decomposes into an extremely rich soil. Only less fertile is the reddish earth of the centre, marking the position of a former lagoon; the island having been raised to its present level by successive stages. This characteristic, together with the successful introduction of the new *régime* of government, foreshadows prosperity for this fragment of the Empire.

POLAR REGIONS.

The Antarctic Ice.—The supplement to *Petermanns Mitt.*, No. 144, 1903, contains in diary form M. Henryk Arctowski's observations on ice, snow, etc., during the Belgian expedition. He describes the form of the icebergs, and the process of erosion and melting. Many of them exhibit grooves excavated along the water-line, and sometimes elevated above the sea by unequal melting on the submerged portion or on the surface. In January, 1899, M. Arctowski examined the structure of ice which had been formed since the beginning of the previous July. On the surface lay some remains of snow turned into *firn*. Below it lay hard blue ice, and then succeeded a layer containing much salt water—salter, perhaps, than the sea-water. Next was a layer of sea-ice, which easily broke in a vertical direction, and, exposed to air at freezing-point or a temperature a little lower, separated into small fragments. A second watery layer was in many cases present, and below there was a thick layer of green ice, with white stripes becoming finer downwards and cellular above; they are evidently produced by the secretion of gas during the

process of freezing. This layer passed almost imperceptibly into the lowest layer of compact ice of a reddish or brownish colour. It had a glass-like fracture, and had evidently been formed very slowly. A remarkable phenomenon was the number of icebergs imprisoned in the pack near the winter quarters of the *Belgica*. M. Arctowski also reports observations on snow-crystals, etc.

MATHEMATICAL AND PHYSICAL GEOGRAPHY.

Vertical Distribution of Temperature in the Atmosphere.—At the meeting of the Paris Academy of Science, held on January 4 last, M. Teisserenc de Bort presented a summary of the results of five years' air-temperature observations by means of sounding-balloons in the neighbourhood of Paris (*C. Rd.*, 1904, No. 1). The observations extend from the level of the surface to a height of 14 kilometres (45,900 feet) above it, being taken at every 500 metres up to 5 kilometres, and at every kilometre above that height. Above 10 kilometres (32,800 feet) the observations depend on 141 ascents only, while apart from the series obtained by these, data were obtained for lower levels from 581 ascents; and the results of the two sets of observations are presented separately. The mean decrease in temperature with the altitude is slight for the lower layers, and the phenomenon of inversion is of frequent occurrence up to a height of 3 or 4 kilometres (about 10,000 to 13,000 feet), especially at night. By day it is observed regularly above cloud-strata (which act on the air in a similar way to the surface of the Earth), and sometimes occurs even without clouds; the condition generally necessary for its occurrence being the possibility of the air changing its temperature *in situ*, either by contact with the surface of the soil or of clouds, or by radiation. From 6 kilometres (19,600 feet) to 10 or 11 kilometres (32,800 to 36,000 feet), the decrease is not, as a rule, subject to these special causes of irregularity; but at about 11 kilometres an unexpected phenomenon has been observed, the decrease becoming extremely slight, or even giving place to an increase. M. de Bort names this zone the "isothermal zone," and says that the phenomenon is quite independent of time or season; but he reserves for the present the discussion of probable explanation.

Movements of Underground Waters.—The aridity of the western states has caused the United States Geological Survey to pay particular attention to various sources of water-supply, and it publishes *Water Supply and Irrigation Papers*, in one of which (No. 67) Mr. C. S. Slichter deals with the flow of underground waters near the surface and at great depths, and with various modes of tapping these supplies. The movement of water through a column of rock depends on the head of water, the depth of the column, and the size and porosity of the soil grain. The flow varies as the square of the size of the grain; it also varies with the temperature, being about twice as large at 70° as at 32°. Mr. Slichter gives a formula in which all these factors are accounted for. He also describes a new method he has devised of determining the rate of flow of underground waters by charging wells with an electrolyte. Of numerous electrolytes that have been tried, ammonium chloride has given the most satisfactory results. Water may be obtained by infiltration galleries cut at right angles to the direction of flow; they lower the level of the underground waters and have often proved disappointing where the amount of flow has not been previously investigated. Sub-surface dams built down to the impervious rock raise the level of the water. One made on Pacoima creek, Los Angeles county, California, enabled fruit-growing to be carried on successfully in the dry years 1898–1900. With all these methods there is a risk of drawing off the water more quickly than the supply can be replenished. Lastly, Mr. Slichter discusses artesian wells, the measurement of their yield and the causes of their

failure. Sometimes they become partially clogged, either by the deposit of silt in the pores of the rock, by a growth of microscopic plant life, or other impediment. At Savannah a strong flushing of the wells by forcing into them a large quantity of water had a very beneficial effect.

GENERAL.

Captain Lenfant's Return.—Captain Lenfant landed at Plymouth, on his way home from West Africa, on March 26, and proceeded on the same day, *viâ* Dover and Calais, to Paris, where he was enthusiastically received. Colonel J. C. Dalton, a member of our Council, was deputed to welcome the explorer in the name of the Society on his landing at Plymouth, and though this arrangement was frustrated owing to the arrival of the ship in the early hours of the morning, a letter of congratulation on the successful termination of his expedition was presented to him from Sir Clements Markham, to which a reply, couched in terms of warm appreciation, has since been received. We hope that Captain Lenfant may communicate to the Society some of the geographical results of his most successful expedition.

An English Metric System.—The possibility of the introduction of the metric system into the empire is by this time, probably, at the back of most men's minds, and in some (those of geographers amongst these) occupies a prominent place. Mr. Thomas Barber, the British Vice-Consul at Oran, is therefore in good time with his pamphlet entitled "Regularity, Simplicity, and Clearness introduced into English Measures." It has suffered rather seriously at the hands of the French printers, but is remarkably lucid. If the system is to be adopted at all, he premises two alternatives—the adoption of the French system as it stands; or a system allied to this, but correcting its errors. Choosing the second, he writes, "the learned authors of the metric system were in error when they imagined a day divided into ten parts and a circle of 400°, thus establishing between these two similar quantities an artificial relation which is not decimal. . . . They were also deceived in thinking that it was possible to break from traditions" as regards the twenty-four hours' day, and again in "the choice of a number which does not include the factor three for the numerical expression of the circumference," since the relations between the triangle and the circle require this factor. Here and in working out his results, Mr. Barber follows M. de Sarrauton, of the Oran Geographical Society, whose proposals as to the division of time and angles, set forth in the *Geographical Journal*, vol. xl. pp. 674 *et seq.*, divide the circumference and the mean solar day into twenty-four hours, the hour into 10°, and so on. The tables worked out by Mr. Barber show, in measures of length, surface, solidity, capacity, weight, and monies, the numerical relation with the principal unit, proposed provisional names of new measures, equivalent in French measures, and actual equivalent in the same. Thus, his new mile is equivalent to 1,666·666 metres, his new pound to 578·7037 grammes, and his new crown to five francs. The main interest lies in his selection of principal units and of names. In long measure he finds two of the former necessary—the fathom, 1000 in a mile, and the yard, in terms of which (for the sake of familiarity, presumably) the measures below it are calculated. In capacity the unit is the gallon, in weight the pound. In money it is the crown, of which the shilling is one-fifth, and the pound equals five. Perhaps this unit is unnecessarily high; the idea is to strike a unit in proportion to the common prices of common objects of sale. The hundredth part of the crown, says Mr. Barber, is the cent (a word to which some might object); "one could admit the farthing, but the centime . . . has fallen into disuse." This may be so, but the Norwegian and Swedish "öre" and the German "pfennig" have not done this. In view of the

fact that such words as inch, metre (Anglicized), halfpenny, and farthing find no place in Mr. Barber's scheme, it is probably worth considering whether such terms should not be retained for familiarity's sake, even though their new proportions to the principal units wholly divorce them from their existing values.

OBITUARY.

Commander Thomas A. Hull, R.N.

By the President.

Thomas A. Hull had been a Fellow of our Society for nearly thirty years, one who took a deep interest in our work, always ready to help, a genial companion, and a faithful friend. Born at Chiselhurst and educated at Christ's Hospital, young Hull entered the navy in 1845 as a master's assistant on board the surveying ship *Herald*, under Captain Kellett. He served on the west coast of South America, and received an admirable training as a surveyor. He was also in charge of the *Herald's* decked pinnace during the running survey of the Gulf of California. In September, 1851, he became a second master, and was appointed to the *Plover* under Captain Maguire, his old first lieutenant in the *Herald*, for Arctic service. The *Plover* was stationed at Point Barrow as a depôt and relief ship for the *Enterprise* and *Investigator*. Hull had special charge of the magnetic observations, which were communicated to the Royal Society by Sir E. Sabine (see *Philosophical Transactions*, 1857). Hull surveyed Port Moore, near Point Barrow, to which station the *Plover* was advanced in 1852.

Returning from his Arctic service in 1854, Hull was promoted and appointed master of the *Havannah*. He served in her until 1859, when he was presented with a sextant by the Lords of the Admiralty for his surveying services in the Pacific. In December, 1859, he was appointed to the Hydrographic Department to compile the 'Admiralty Pilot' for the Straits of Magellan and west coast of South America. He was next assistant surveyor in the *Firefly*, surveying the coast of Palestine, Corfu, and Sicily from 1860 to 1866. From 1866 to 1873, Hull was naval assistant to the hydrographer, and compiled the wind and current charts under the direction of Captain Evans. In August, 1873, he was appointed Superintendent of Admiralty Charts and Examiner in nautical surveying at the Naval College at Greenwich. He was promoted to the rank of commander (retired) on August 23, 1878.

Commander Hull was the author of 'Practical Nautical Surveying.' He also gave Admiral Sir F. Bedford considerable assistance in the preparation of his 'Sailor's Pocket-book.' In 1873 he gave a lecture at the United Service Institute entitled "The Unsurveyed World." This paper was very suggestive, and contained much valuable information. But it gave offence in official regions, and led eventually to the very unfair dismissal of this excellent surveyor. His dismissal took place on December 1, 1879. But Commander Hull had many friends, and he was not long unemployed. At first he was occupied in bringing the charts up to date on board the mail steamers. The closing years of his life were happily passed in congenial work, sometimes as master of a friend's yacht, at others conducting tourists on board large steamers. Always busy, always promoting the amusement or welfare of others, his last years were probably not the least happy in his long and useful life. Many warm friends will mourn his loss. Commander Hull died at his house, Mamre, Honor Oak, on March 25 last.

Robert M. W. Swan.

We regret to record the death, which took place on March 26 last, of Mr. R. M. W. Swan, well known for his share in the earlier investigations of the ruins of Mashonaland. Mr. Swan was born in 1858, and after receiving a technical training in Glasgow University and in the laboratory of Mr. R. Tattock, went out to Spain in 1878 in the capacity of a mining expert. In 1879 he went to Greece, and the next seven years were spent in mining work, principally in Antiparos and neighbouring islands. In addition to his professional employment, he devoted much attention to archæology, publishing several papers on his researches, and sending many specimens to the British Museum. It was during this period that he first made the acquaintance of Mr. and Mrs. Theodore Bent, whom he accompanied during their visits to several of the islands, afterwards taking part in the expedition to Mashonaland, carried out by them in 1891, for the examination of the Zimbabwe and other ruins. During this expedition he undertook the cartographic portion of the work, executing for the first time a careful plan of the ruins, besides mapping the country along the routes followed, and fixing the positions of a number of points astronomically. When, after his return to this country, Mr. Bent described the results of his journey before the Society, Mr. Swan added some notes on the geography and meteorology of Mashonaland, and subsequently contributed to the *Proceedings* (May, 1892) a short paper on the orientation of the ruins, showing in a striking way the close connection which existed between the arrangement of the structures and the astronomical phenomena to which, as sun-worshippers, their builders had paid so much attention. The subject was more fully discussed in the section which he contributed to Mr. Bent's "Ruined Cities of Mashonaland." The theory which he developed was subjected to some criticism, but on returning to South Africa to continue his investigations, he collected *data* which, as he claimed, fully bore out his ideas. During this journey, carried out in 1893, he examined various ruins, till then undescribed, besides doing something to improve the mapping of the country along his route, which led inland by way of the Limpopo.

This visit to South Africa lasted about two years, spent in part in geological and mining work. In 1896 he examined the mining districts of Western Australia and Tasmania, and in 1898 went to Siam with a similar object, leaving again, after a short visit to this country, for the Malay peninsula, where he was engaged in mining work until his death, which took place at Kuala Lumpur after an operation for abscess of the liver. Here, as in South Africa, he did much careful cartographical and geological work.

Mr. Swan was an expert linguist, and from his residence in Greece had acquired a great love for the classics. He possessed a large store of knowledge on varied subjects, which he was always anxious to share with others. He was a Fellow of the Geological and Chemical Societies, as well as of our own, which he joined in 1893, having received the Murchison Grant in 1892.

Captain G. H. F. Abadie.

The premature death of this promising young officer deprives Sir Frederic Lugard of a valued assistant, who had already done excellent work in Nigeria both of a political and a geographical nature. The deceased officer, who was born in 1873, was the second son of Major-General H. R. Abadie, C.B., Lieut.-Governor of Jersey. Entering the army in 1893, he resigned his commission in 1897, but rejoined two years later on obtaining a commission in the Royal Scots regiment. He served in Nigeria during the military operations of 1899 to 1902, and was several times

mentioned in despatches, obtaining his captaincy in the latter year. He was also made a C.M.G. and appointed resident at Zaria, a post of much responsibility in the critical state of affairs lately existing in the territory. During the military operations which led to the overthrow of Kano and Sokoto, he executed careful surveys of the routes, and full testimony to the value of his work in this direction was borne by Sir F. Lugard in his paper read before the Society in November last. His death occurred at Kano on February 11, as the result of a severe attack of fever.

The Hon. H. P. Vereker.

Mr. Vereker, who died, during March, at his residence in the Isle of Wight, in his eightieth year, was a Fellow of the Society of considerable standing, having joined so far back as 1863. Fourth son of the 3rd Viscount Gort, he was educated at Trinity College, Dublin, where he obtained high mathematical honours and the degree of LL.D. After holding several appointments in Ireland, he became Consul Rio Grande de Sul in 1852, and for the next forty years held various posts of a like character, mostly abroad, becoming consul at Cherbourg in 1876, and retaining the post until his retirement in 1894.

MEETINGS OF THE ROYAL GEOGRAPHICAL SOCIETY, SESSION 1903-1904.

Tenth Ordinary Meeting, March 21, 1904.—Sir CLEMENTS MARKHAM, K.C.B., F.R.S., President, in the Chair.

ELECTIONS.—*Sir Robert Filmer, Bart.; Rev. A. B. Fisher; Captain H. W. Gordon, R.E.; Arthur Hawley; Cyril Norris Irven; William Latta; Ambrose Yarburgh Lethbridge; Grant Squiers; Charles Ernest Thomson; Captain Robert Arnold Vansittart.*

The Paper read was:—

"The Swedish Antarctic Expedition." By Dr. Otto Nordenskiöld.

GEOGRAPHICAL LITERATURE OF THE MONTH.

Additions to the Library.

By EDWARD HEAWOOD, M.A., *Librarian*, R.G.S.

The following abbreviations of nouns and the adjectives derived from them are employed to indicate the source of articles from other publications. Geographical names are in each case written in full:—

A. = Academy, Academie, Akademie.
Abh. = Abhandlungen.
Ann. = Annals, Annales, Annalen.
B. = Bulletin, Bollettino, Boletim.
Com. = Commerce.
C. Rd. = Comptes Rendus.
Erdk. = Erdkunde.
G. = Geography, Geographie, Geografia.
Ges. = Gesellschaft.
I. = Institute, Institution.
Iz. = Izvestiya.
J. = Journal.
k. u. k. = kaiserlich und königlich.
M. = Mitteilungen.
Mag. = Magazine.
Mem. = Memoirs, Mémoires.
Met. = Meteorological.
P. = Proceedings.
R. = Royal.
Rev. = Review, Revue.
S. = Society, Société, Selskab.
Sitzb. = Sitzungsbericht.
T. = Transactions.
V. = Verein.
Verh. = Verhandlungen.
W. = Wissenschaft, and compounds.
Z. = Zeitschrift.
Zap. = Zapiski.

On account of the ambiguity of the words *octavo*, *quarto*, etc., the size of books in the list below is denoted by the length and breadth of the cover in inches to the nearest half-inch. The size of the *Journal* is 10 × 6½.

A selection of the works in this list will be noticed elsewhere in the "Journal."

EUROPE.

France—Aunis. **D'Almeida.**

L'Aunis. Essai de Géographie Historique et Régionale. Par M. P. Camena d'Almeida. (Extrait du B. G. historique et descriptive, No. 2, 1903.) Pp. 7. *Presented by the Author.* [See note, *ante*, p 689.]

France—Haute-Saône. *Ann. G.* **12** (1903): 453–456. **Delépine.**

Observations sur le régime hydrographique de la rive droite de l'Ognon. Par l'Abbé G. Delépine.

France—Jura. *Ann. G.* **12** (1903): 403–410. **Rollier.**

Le plissement de la chaîne du Jura. Par L. Rollier. *With Map.*

France—Vendée. *Ann. G.* **13** (1904): 56–63. **Sorre.**

Régime pluviometrique de la Vendée. Par Maximilien Sorre. *With Maps.*

France—Water-power. *Ann. G.* **13** (1904): 37–55. **Audebrand.**

La Houille blanche en France; son état présent; son avenir. Par le Commandant A. Audebrand. *With Map and Plate.*

Germany.

Handbuch der Wirtschaftskunde Deutschlands, herausgegeben im Auftrage des Deutschen Verbandes für das Kaufmännische Unterrichtswesen. Erster, zweiter Band. Ditto. Dritter Band. Die Hauptindustrien Deutschlands. Leipzig: B. G. Teubner, 1901–1904. Size 10½ × 7, pp. (vol. i.) viii. and 331; (vol. ii.) 253; (vol. iii.) xii. and 1048. *Maps. Price* 10, 6, *and* 30*m. Presented by the Publisher.*

To be reviewed.

Germany—Navigation. **Franconie.**

B.S.G. Commerc. Havre **20** (1903): 257–273, 321–340.

Les Progrès de la Navigation Maritime et Intérieure en Allemagne. Par J. Franconie.

Germany—Rhine Province. **Philippson.**

Zur Morphologie des Rheinischen Schiefergebirges. Vortrag gehalten auf dem XIV. Deutschen Geographentag in Koln, 1903. Von Prof. Dr. A. Philippson. (Sonderabdruck aus: Verh. des XIV. Deut. G.-Tages zu Koln, 1903.) Berlin, 1903. Size 9 × 6½, pp. 193–205. *Sections.*

Gibraltar. *Quarterly J. Geol. S.* **60** (1904): 30–36. **Acland**

On a New Cave on the Eastern Side of Gibraltar. By Henry Dyke Acland. *Plate.*

Italy. **Baedeker.**

Italy. Handbook for Travellers. By K. Baedeker. Second Part: Central Italy and Rome. Fourteenth Revised Edition. Leipzig: K. Baedeker; London: Dulau & Co., 1904. Size 6½ × 4½, pp. lxxvi. and 470. *Maps and Plans. Price* 7*m.* 50*c. Two Copies. Presented by the Editor and by Messrs. Dulau & Co.*

Italy. **Maugham.**

The Book of Italian Travel (1580–1900). By H. N. Maugham. London: Grant Richards, 1903. Size 8 × 5½, pp. viii. and 460. *Illustrations. Price* 10*s.* 6*d.*

Descriptions and impressions of Italian towns brought together from the writings of the most famous travellers from Montaigne onwards.

Italy—Abruzzi. **Abbate.**

Guida dell' Abruzzo di Enrico Abbate. Roma: E. Loescher & Co., 1903. Size 7 × 5, pp. viii., 402, and 558. *Maps. Price* 12*l. Presented by the Publishers.*

In addition to the ordinary guide-book material in the form of itineraries, this work contains instructive chapters on the general features of the district, its flora, geology, history, etc., which give it some value from a geographical point of view.

Italy—Naples. **Günther.**

Contributions to the Study of Earth-movements in the Bay of Naples. I. The Submerged Greek and Roman foreshore near Naples. II. Earth-movements in

the Bay of Naples. By R. T. Günther. Oxford: Parker & Son, 1903. Size 12 × 9½, pp. 62 and 50. *Map, Plans, and Illustrations. Price* 10*s. net. Presented by the Author.*

The first memoir, reprinted from *Archæologia*, contains interesting reproductions of old prints, illustrating the changes to which the shore-line has been subject in the bay of Naples within historic times. The second paper is reprinted from the *Geographical Journal* for July and August, 1903.

Montenegro and Servia. **Durham.**

Through the Lands of the Serb. By Mary E. Durham. London: Edward Arnold, 1904. Size 9 × 6, pp. x. and 346. *Map and Illustrations. Price* 14*s. net. Presented by the Publisher.*

Switzerland. *Ann. G.* **12** (1903): 411–427. **Lacger.**

De Lausanne à Zermatt, excursion de géographie physique en Suisse. Par l'Abbé L. de Lacger.

United Kingdom—Devonshire. **Lowe.**

The Teign Valley and its Geological Problems. By Harford J. Lowe. (From 'T. Devonshire Ass. for Advanc. of Science,' etc., 1903.) Size 8½ × 5½, pp. 15. *Map. Presented by the Author.*

United Kingdom—Map-Projection. **Close.**

The Projection for the Map of the British Isles on a Scale of 1:1,000,000. By Major C. F. Close. Published under direction of Colonel D. A. Johnston, R.E. Size 8½ × 5½, pp. 10.

United Kingdom—Scotland. *Scottish G. Mag.* **20** (1904): 66–84. **Cadell.**

The Industrial Development of the Forth Valley. By H. M. Cadell. *With Maps and Plate.*

United Kingdom—Scotland. **Maclean.**

The Literature of the Highlands. By Magnus Maclean. London: Blackie & Son, 1904. Size 9 × 6, pp. viii. and 236. *Price* 7*s.* 6*d. net. Presented by the Publishers.*

Among the principal writers whose literary work is spoken of are Alexander Macdonald, Duncan Ban Mackintyre, James Macpherson, and Dugald Buchanan.

United Kingdom—Suffolk. **Dutt.**

Suffolk. By W. A. Dutt. London: Methuen & Co., 1904. Size 6½ × 4, pp. 356. *Map and Illustrations. Price* 3*s. Presented by the Publishers.*

As in others of these guides, there is an instructive sketch of the general physical features, climate, flora, and fauna, etc., of the county.

United Kingdom—Sussex. **Lucas.**

Highways and Byways in Sussex. By E. V. Lucas, with Illustrations by F. L. Griggs. London: Macmillan & Co., 1904. Size 8 × 5½, pp. xx. and 424. *Map. Price* 6*s. Presented by the Publishers.*

ASIA.

China. **Jack.**

The Back Blocks of China. A Narrative of Experiences among the Chinese, Sifans, Lolos, Tibetans, Shans, and Kachins, between Shanghai and the Irrawadi. By R. Logan Jack. London: Edward Arnold, 1904. Size 9 × 6, pp. xxii. and 270. *Map and Illustrations. Price* 10*s.* 6*d. net. Presented by the Publisher.* [To be reviewed.]

French Indo-China. *Ann. G.* **12** (1903): 428–439. **Mille.**

Projets de canaux de navigation et d'irrigation en Indo-Chine. Par P. Mille. *With Maps.*

French Indo-China—Cambodia. **Aymonier.**

Le Cambodge. III. Le Groupe d'Angkor et l'Histoire. Par Etienne Aymonier. Paris: E. Leroux, 1904. Size 11 × 7½, pp. 818. *Plans and Illustr. Price* 25 *fr.*

India—Earthquake. *Mem. Geol. Survey India* **35**, *Part* 2 (1903): 1–34. ——

The Diurnal Variation in Frequency of the Aftershocks of the Great Earthquake of June 12, 1897. By R. D. Oldham. *Diagrams.*

India—Himalayas. **Guillarmod.**

Dr. J. Jacot Guillarmod. Six mois dans l'Himalaya, le Karakorum et l'Hindu-Kush. Voyages et explorations aux plus hautes Montagnes du Monde. Neuchatel: W. Sandoz, [not dated]. Size 9½ × 6½, pp. 364. *Maps and Illustrations. Price* 20 *fr. net. Presented by the Publisher.* [To be reviewed.]

Indo-China—Funan. *J. Asiatique*, 10e *Ser.* **2** (1903): 333–341. **Aymonier.**

Nouvelles observations sur le Founan. Par M. Etienne Aymonier.

Indo-China—Waterways and Railways. *Asien* **3** (1903): 20–22. **Kleist.**

Die Wasserstrassen und Eisenbahnen von Indo-Chine. Von Kleist. *Map.*

Japan. **Sladen.**

Queer Things about Japan. By Douglas Sladen. Second Impression. London: A. Treherne & Co., 1904. Size 9 × 6, pp. xxxvi. and 344. *Illustrations. Price* 21*s. net. Presented by the Publishers.*

Japan and China. **Brinkley.**

Japan and China: their History, Arts, and Literature. By Captain F. Brinkley. Vols. viii.–xii. London: T. C. & E. C. Jack, 1904. Size 9½ × 6½, pp. (vol. vii.) 396; (vol. viii.) 450; (vol. ix.) 426; (vol. x.) 274; (vol. xi.) 286; (vol. xii.) 292. *Map and Plate.*

Vols. ix.–xii. deal with China.

Malay States. *Abh. K.K.G. Ges. Wien* **5** (1703–4): 1–58. **Rowland.**

Ueber die "Federated Malay States" auf der Malayischen Halbinsel und deren Entwicklung unter Britishem Protektorat. Von William R. Rowland. I. Teil.

Persia—Fars. **Witherby.**

An Ornithological Journey in Fars, South-West Persia. By Harry F. Witherby. *With Maps.* (From the *Ibis* for October, 1903.) Size 9 × 6, pp. 501–571. *Presented by the Author.* [See *ante*, p. 682.]

Philippine Island. **Blair and Robertson.**

The Philippine Islands. Edited and annotated by E. H. Blair and J. A. Robertson. Vol. v., 1582–1583 (pp. 320); vol. vi., 1583–1588 (pp. 326); vol. vii., 1588–1591 (pp. 320); vol. viii., 1591–1593 (pp. 320); vol. ix., 1593–1597 (pp. 330); vol. x., 1597–1599 (pp. 318). Cleveland, Ohio: The Arthur H. Clark Company, 1903–1904. Size 9½ × 6½. *Facsimile-maps and Autographs.*

Philippine Islands. *National G. Mag.* **14** (1903): 437–441. **Putnam.**

Surveying the Philippine Islands. By R. Putnam. *With Illustrations.*

AFRICA.

Egypt—Nile and Sudan. **Peel.**

The Binding of the Nile and the New Soudan. By the Hon. Sidney Peel. London: Edward Arnold, 1904. Size 9 × 6, pp. viii. and 288. *Map and Portrait. Price* 12*s.* 6*d. net. Presented by the Publisher.*

The first part of this work treats of the recent reservoir construction and further irrigation projects; the second takes stock of the present condition of the Sudan.

German East Africa—Urundi. *Deuts. Kolonialblatt* **15** (1904): 6–12. **Beringe.**

Bericht des Hauptmanns v. Beringe über die Expedition nach Urundi.

German South-West Africa. *La G., B.S.G. Paris* **9** (1904): 116–119. **Chesneau.**

Le Pays des Héréros. Par M. Chesneau. *With Map.*

Ivory Coast. *B.S.G. Marseille* **27** (1903): 129–247. **Mondon.**

La Côte d'Ivoire: Les Lagunes, La Barre, Grand Bassam, Bingerville. Par Dr. C. Mondon. *With Map.*

Sahara. **Foureau.**

Documents Scientifiques de la Mission Saharienne, Mission Foureau-Lamy d'Alger au Congo par le Tchad. Par F. Foureau, Chef de la Mission. Premier Fascicule: Introduction; Observations Astronomiques et Météorologiques. (Publication de la S. de G.) Paris: Masson et Cie., 1903. Size 13 × 10, pp. 162.

South Africa. **Knight.**

South Africa after the War. A narrative of recent travel. By E. F. Knight. London: Longmans & Co., 1903. Size 9 × 6, pp. xii. and 356. *Illustrations. Price* 10*s.* 6*d. net.*

South Africa. ———

Labour and other Questions in South Africa, being mainly considerations on the rational and profitable treatment of the coloured races living there. By "Indicus." London: T. Fisher Unwin, 1903. Size 8 × 5½, pp. xii. and 146. *Presented by the Publisher.*

Results of personal inquiry and observation on the questions now agitating South Africa.

Tripoli. **Mathuisieulx.**

Renseignements Coloniaux, Com. Afrique française, No. 1 (1904): 20–33.

Une Mission en Tripolitaine. Par H. Méhier de Mathuisieulx. *With Sketch-map.*

West Africa—Franco-Spanish Delimitation. **de Mézières.**

Rev. Coloniale **15** (1903): 278–293.

Mission Bonnel de Mézières. Commission franco-espagnole de limitation du Golfe de Guinée. Rapports du Chef de Mission.

West Africa. *La G., B.S.G. Paris* **9** (1904): 73–78. **Lenfant.**

La mission Lenfant de la Benoué au Tchad.

See Monthly Record for April, *ante*, p. 522.

NORTH AMERICA.

United States—Industries. *National G. Mag.* **14** (1903): 301–320. **Austin.**

The United States: her Industries. By O. P. Austin. *With Diagrams.*

United States—Meteorology. *G.Z.* **9** (1903): 575–578. **Krug-Genthe.**

Der Chinook. Von Dr. Martha Krug-Genthe.

United States—Minnesota. **Clements.**

The Vermilion Iron-bearing District of Minnesota, with an Atlas. By J. M. Clements. (United States Geological Survey, Monographs, vol. xlv.) Washington, 1903. Size 12 × 9½, Atlas 22 × 18½, pp. 464. *Maps and Illustrations. Presented by the United States Geological Survey.*

CENTRAL AND SOUTH AMERICA.

Brazil—Communications. **Novaes.**

These sobre a viação ferrea geral e navegação fluvial do Brazil lida em sessão do Centro do Sciencias, Letras e Artes de Campinas pelo Vice-President José de Campos Novaes. Campinas, 1902. Size 10 × 7, pp. 66. *Presented by the Centro de Sciencias de Campinas.*

Brazil—Rio Branco. **Hübner.**

Deutsch Rundschau G. **25** (1903): 253–266, 351–359, 458–462, 551–564.

Forchungsreisen am Rio Branco. Von G. Hübner. *With Illustrations.*

Brazil—São Paulo. **Bueno.**

Rev. Centro Sci. Campinas **2** (1903): 21–32, 79–84, 154–161.

A Cidade de São Paulo, (Recordações). Dr. Francisco de Assis Vieira Bueno.

Chile. **Steffen.**

Bericht über eine Reise in das Chilenische Fjordgebiet nördlich vom 48° S. Br. Von Dr. Hans Steffen. Valparaiso, 1903. Size 9½ × 6½, pp. 80. *Map.*

Martinique. *G. Z.* **9** (1903): 545–559. **Wegener.**

Am Mont Pelé im März 1903. Von Dr. G. Wegener.

Paraguay. **Grubb.**

Among the Indians of the Paraguayan Chaco: a Story of Missionary Work in South America. Told by W. B. Grubb and his fellow-workers in the Chaco Mission of the South American Missionary Society. With a Preface by the Right Rev. W. H. Stirling, D.D., first bishop of the Falkland Islands. Edited by Gertrude Wilson. London: C. Murray & Co., 1904. Size 9 × 6, pp. xiv. and 176. *Map and Illustrations. Presented by the Author.*

Peru—Sailing directions. **Melo.**

Derrotero de la Costa del Peru. Rosendo Melo. Lima: Carlos F. Southwell, 1903. Size 9 × 6½, pp. iv. and 28. *Plans and Illustrations.*

Salvador. *An. Museo Nac. San Salvador* **1** (1903): 122–126. ——

Influencia del clima de las alturas salvadoreñas en la salud del hombre.

Straits of Magellan. **Lübcke.**

Kaiserliche Marine. Deutsche Seewarte. Dampferwege durch die Magellan-Strasse und den Smyth-Kanal. Anweisung für Dampfer-Kapitäne von Kapitän Charles Lübcke. (Sonderabdruck aus 'Der Pilote,' neue Folge, Band II. von 1903.) Hamburg: Eckardt & Messtorff, 1903. Size 9½ × 6½, pp. viii. and 204. *Charts and Illustrations.*

West Indies—Dominica. **Sterns-Fadelle.**

The Boiling Lake of Dominica. A historical and descriptive account. By F. Sterns-Fadelle. Roseau [n.d.]. Size 8½ × 5½, pp. 26.
Domenica, a fertile island. By the same. pp. 28.

AUSTRALASIA AND PACIFIC ISLANDS.

New Zealand. **Dadelszen.**

The New Zealand Official Year-Book, 1903. Prepared by E. J. von Dadelzen. Wellington, 1903. Size 8½ × 6, pp. vi. and 756. *Map and Illustrations.*

Tasmania—Geology. *Quarterly J. Geol. S.* **60** (1904): 37-53. **Gregory.**

Contribution to Glacial Geology of Tasmania. By Prof. J. W. Gregory. *Plates.*
See note in the March number.

POLAR REGIONS.

Antarctic—Swedish Expedition. *Petermanns M.* **50** (1904): 28-31. **Andersson.**

Berichte von der schwedischen Südpolar-Expedition. Von Dr. H. G. Andersson.

Arctic. *La G., B.S.G. Paris* **9** (1904): 105–115. **Simmons.**

Études botaniques exécutées dans l'archipel polaire américain par l'expédition Sverdrup. Par H. G. Simmons. *With Map.*

Arctic—Exploration. *National G. Mag.* **14** (1903): 429–436. **Peary.**

The Value of Arctic Exploration. By Commander R. E. Peary.

Arctic—Norwegian Expedition. **Sverdrup.**

New Land: Four Years in the Arctic Regions. By Otto Sverdrup. Translated from the Norwegian by Ethel Harriet Hearn. Two vols. London: Longmans & Co., 1904. Size 10 × 6, pp. (vol. i.) xvi. and 496; (vol. ii.) xii. and 504. *Maps and Illustrations. Price 36s. net. Presented by the Publishers.* [To be reviewed.]

MATHEMATICAL GEOGRAPHY.

Navigation. **Hall.**

The Organized Science Series. Modern Navigation. A Text-book of Navigation and Nautical Astronomy suitable for the Examinations of the Royal Navy and the Board of Education (South Kensington). By William Hall. London: W. B. Clive, 1904. Size 7 × 5, pp. viii., 378, and xv. *Illustrations. Price 6s. 6d. Presented by the General Editor.*

PHYSICAL AND BIOLOGICAL GEOGRAPHY.

Glaciers. **Finsterwalder and Muret.**

Commission Internationale des Glaciers. Les variations périodiques des Glaciers. Huitième Rapport, 1902, rédigé par le Dr. Finsterwalder et E. Muret. (Extrait des Archives des Sciences physiques et naturelles, t. xv. et xvi., 1903.) Genève: Georg & Cie., 1903. Size 9 × 6, pp. 36.

Meteorology. *Ciel et Terre* **24** (1903): 82-90, 105–118. **Hildebrandsson.**

Sur la circulation générale de l'atmosphère. Par H. H. Hildebrandsson.

Meteorology—Climate. *Symons's Meteor. Mag.* **39** (1904): 2–5. **Bonacina.**

Atmospheric Pressure as a Factor of Climate. By L. Bonacina.

Meteorology—Radiation. **Very.**

Atmospheric Radiation: a Research conducted at the Allegheny Observatory and at Providence, R.I. By Frank W. Very. (Bul. G., U.S. Department of Agriculture, Weather Bureau.) Size 11½ × 9½, pp. 134.

Phytogeography. **Colville and Macdougal.**

Desert Botanical Laboratory of the Carnegie Institute. By Frederick Vernon Colville and Daniel Trembly Macdougal. Washington: Carnegie Institution, 1903. Size 10 × 7, pp. 58. *With Maps and Plates. Presented by the Botanical Society of America.*

Volcanoes. **Haas.**

Der Vulkan. Die Natur und das Wesen der Feuerberge im Lichte der neueren Anschauungen für die Gebildeten aller Stände in gemeinfasslicher Weise dargestellt von Dr. H. Haas. Berlin: A. Schall, [1903]. Size 8 × 5, pp. 340. *Illustrations.*

Volcanoes. *Ann. G.* **12** (1903): 385–402. **Lapparent.**

Le Volcanisme. Par A. de Lapparent.

Volcanoes. **Reclus.**

Proposition de dresser une Carte authentique des Volcans. Par Elisée Reclus. (Extrait du No. 11 (1903) du B.S. belge d'Astronomie.) Bruxelles. Pp. 61.

Whirlwinds and Whirlpools. *Ann. G.* **13** (1904): 1–20. **Brunhes.**

Les analogies des tourbillons atmosphériques et des tourbillons des cours d'eau, et la question de la déviation des rivières vers la droite. Par B. Brunhes et J. Brunhes.

Zoogeography. *C. Rd. A. Sci.* **138** (1904): 384–389. **Calvert.**

La distribution Géographique de Bryozoaires marins et la théorie de la bipolarité. Note de M. L. Calvert.

ANTHROPOGEOGRAPHY AND HISTORICAL GEOGRAPHY.

Commercial—Ports and Docks. **Owen.**

Ports and Docks, their History, Working, and National Importance. By Douglas Owen. London: Methuen & Co., 1904. Size 8 × 5½, pp. 180. *Illustrations. Price 2s. 6d. net. Presented by the Publishers.*

Political Geography—Areas. *G.Z.* **9** (1903): 685–693. **Wagner.**

Vorschläge zur Vervollständigung offizieller Arealangaben. Vortrag gehalten bei der ix. Tagung des Internationalen Statistischen Instituts zu Berlin von Hermann Wagner.

The special directions in which the need of reform is urged are (1) the more precise correlation of cadastral with geodetic surveys, (2) the more accurate definition of water-boundaries.

NEW MAPS.

By E. A. REEVES, *Map Curator*, R.G.S.

EUROPE.

England and Wales. **Ordnance Survey.**

ORDNANCE SURVEY OF ENGLAND AND WALES:—Sheets published by the Director-General of the Ordnance Survey, Southampton, from March 1 to 31, 1904.

10 miles to 1 inch—

Great Britain, coloured map of. The sheets of this map have been printed for mounting as one map, together with a title-sheet and marginal lines. 9*s.* per set; mounted on holland and bound with blue ribbon, 21*s.*; varnished and mounted on mahogany moulding and roller, 27*s.*

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and 56 N.E.), 51 N.W. (56 N.E. and 50 S.E.). **Worcestershire**, 13 N.E., 21 N.W., 22 N.W. (First Revision of 1891 Survey). **Yorkshire** 295 N.E., 297 N.W. 1*s. each.*

25-inch—County Maps (first revision):—

Brecknockshire, XVI. 1; XVII. 11, 12. **Gloucestershire**, LXXV. 8; LXXVI. 1, 2, 7, 12. **Herefordshire**, II. 14; VIII. 6; XVIII. 13; XX. 11; XXIII. 4; XXIV. 1, 4, 6, 7, 8, 12, 13; XXVI. 13, 14, 15, 16; XXVII. 13, 14, 15, 16; XXVIII. 13, 14, 15, 16; XXIX. 5, 9, 13; XXX. 12; XXXI. 1, 2, 3, 4, 7, 8, 9, 10, 11, 12; XXXIII. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 14; XXXIV. 1, 2, 3, 5, 6, 7, 8, 11; XXXV. 1, 3, 5, 6, 7, 9, 11, 12, 15. **Leicestershire**, II. 4, 15, 16; VII. 3, 9, 10, 11, 13, 14, 15, 16; XIII. 3, 4, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16; XX. 1, 2, 3, 4, 7, 8, 11, 12, 13, 14, 15, 16; XXVII. 3, 4, 5, 6, 9, 10, 11, 12, 13, 14, 15, 16; XXIX. 4; XXXI. 10, 14; XXXIII. 10; XXXVII. 10, 11; XLIV. 4; XLV. 8; XLVI. 8, 10, 13, 14, 15, 16; XLVIII. 16; XLIX. 13; L. 11, 12; LI. 1; LII. 4, 8, 12; LIII. 5. **Lincolnshire**, CXII. 4, 16; **Radnorshire**, XXXIII. 4; XXXIV. 1, 13; XXXVI. 10, 11, 12. **Rutland**, I. 16; IV. 3, 4, 12, 16. **Shropshire**, LXXVII. 14; LXXXIII. 6; LXXXIV. 2. **Somersetshire**, XXXVI. 13; XLVII. 10, 13, 14; XLVIII. 6; XLIX. 11, 12, 16; L. 1, 2, 4, 5, 9, 13; LI. 1, 9, 11, 12, 13, 14, 15, 16; LII. 14; LVIII. 2, 4, 5, 6, 7; LIX. 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16; LX. 9, 14, 15; LXI. 9, 10, 12, 13, 14, 15, 16; LXII. 1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14, 15, 16; LXVII. 4, 7, 8; LXX. 7. **Staffordshire**, LXVII. 8, 12, 16; LXVIII. 5, 9, 10, 12, 13; LXIX. 5, 6, 9; LXX. 10; LXXII. 5. **Suffolk**, LIII. 3, 4, 7, 8, 11, 12, 15, 16; LXIII. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16; LXIV. 1, 2, 4, 6, 10, 12, 15; LXVII. 1, 2, 6, 7, 12; LXVIII. 1, 2, 3, 4, 8, 15, 16; LXIX. 13; LXX. 2, 3, 4, 6, 7, 8, 10, 12; LXXI. 2, 3, 9; LXXIV. 1, 2, 3, 4, 12, 14; LXXVI. 3; LXXVII. 5, 8; LXXX. 2, 7, 10, 13; LXXXI. 9, 12; LXXXII. 1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 14, 15, 16; LXXXIII. 1, 5, 6, 9, 10, 13, 14; LXXXVI. 1, 2, 4. **Warwickshire**, VIII. 5, 6, 9, 10, 11; XV. 15; XX. 3, 4, 6, 7, 8, 11, 12; XXIII. 4, 8, 12. **Worcestershire and ditto** (Det. 1 and 2) I. 12, 16; II. 13; III. 10, 13; IV. 16; V. 5; XII. 16; XIX. 1, 16; XXVIII. 13, 16; XXIX. 11, 12, 13, 14, 15, 16; XXXII. 7, 8, 12; XXXIII. 5, 6, 9; XXXIV. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12. 3*s. each.*

(*E. Stanford, London Agent.*)

England and Wales. **Geological Survey.**

1-inch map (New Series). Colour printed, 1904.

London District, Drift Map, in four sheets, 1, 2, 3, 4. 1*s.* 6*d. each.*

(*E. Stanford, London Agent.*)

Germany. **Königl. Preuss, Landes-Aufnahme.**

Karte des Deutschen Reiches. Scale 1: 100,000 or 1·6 stat. mile to an inch. Sheets: 209, Amelinghausen; 210, Lüneburg. Herausgegeben von der Kartogr. Abtheilung der Kgl. Preuss. Landes-Aufnahme, 1903. *Price* 1.50 *mark each sheet.*

Russian Empire. **Ministry of Ways and Communications, St. Petersburg.**

Map showing the Steam Communication, Railways, and Postal Routes of the Empire. Scale 1: 4,200,000 or 66·3 stat. miles to an inch. 2 Sheets. St. Petersburg: Ministry of Ways and Communications, 1904. [In Russian.]

An outline map of the Russian Empire, showing clearly means of communication by rail, road, and sea. The principal part of the map is occupied by European Russia, Asiatic Russia and the Trans-Siberian railway being shown only by a separate inset on half the scale of the former.

ASIA.

Asia. **Russian Government.**

Map of the Southern Frontier Regions of Asiatic Russia. Scale 1: 1,168,031 or 18·4 stat. miles to an inch. Sheet XXV., Shiraz. St. Petersburg: Military Topographical Department. [In Russian.]

Eastern Asia. **Stanford.**

Stanford's map of the Seat of War in the Far East, 1904. Scale 1: 1,520,640 or 24 stat. miles to an inch. London: Edward Stanford, 1904. *Presented by the Publisher.*

Railways, roads, rivers and boundaries are laid down in this map, but no attempt has been made to show hill-shading. It is on a larger scale than most maps of its kind, and a special enlarged plan of the neighbourhood of Port Arthur is given as an inset. Only the northern part of Korea is included.

Japan. **Intelligence Branch, Simla.**

Map of Japan. Scale 1: 2,217,600 or 35 stat. miles to an inch. Compiled in

the Intelligence Branch Quarter-Master General's Department in India from all available sources. Simla, 1904. *Presented by the Assistant Quarter-Master General, Intelligence Branch, Simla.*

Kamchatka. **Bogdanowitch and Leliakin.**

Karten von Kamtschatka: Topographische Karte nach der von Berg-Ingenieur K. J. Bogdanowitsch und Kapitän N. N. Leliakin bearbeiteten und 1901 erschienenen Karte in 1 : 840,000. Scale 1 : 2,000,000 or 31·5 stat. miles to an inch.—Geologische Karte von Berg-Ingenieur, K. J. Bokdanowitsch. Scale 1 : 2,000,000 or 31·5 stat. miles to an inch. *Petermanns Geographische Mitteilungen*, Jahrgang 1904, Tafel 5. Gotha: Justus Perthes, 1904. *Presented by the Publisher.*

Korea. **Philip.**

The "Daily Mail" military map of Korea. Scale 1 : 1,000,000 or 15·8 stat. miles to an inch. London: George Philip & Son. *Price 3s. 6d. net.*

An attempt has been made on this map to show the relative elevation of the land by different tints. These are five in number, and range from sea-level to over 6000 feet. As no exact survey of the country exists, this is a somewhat bold venture, and the contour-lines and shading can only be taken as roughly indicating the relief. The map is clearly drawn, and contains five inset plans, with an index to place-names.

Manchuria. **Intelligence Branch, Simla.**

Sketch-map of South Manchuria. Scale 1 : 1,330,560 or 21 stat. miles to an inch. Simla: Intelligence Branch, 1904. *Presented by the Assistant Quarter-Master General, Intelligence Branch, Simla.*

This map has been compiled in the Intelligence Branch, Quarter-Master General's Department of India, from a map of South Manchuria dated 1902, by Colonel G. F. Browne, Military Attaché in China, combined with information obtained from French and Russian maps.

Sumatra. **Topographical Bureau, Batavia.**

Overzichtskaart van Atjèh en Onderhoorighenden. Scale 1 : 200,000 or 3·1 stat. miles to an inch. 16 Sheets. Topographisch. Bureau, Batavia, 1903.

A good general map of Western Sumatra, including the results of explorations and survey work up to the present time. Relief is shown by horizontal form lines in brown and black, and water is in blue. The map contains much detailed information concerning means of communication, military and other stations, boundaries, etc., and is on a sufficiently large scale to be really useful for reference. Many districts are but very imperfectly known, and consequently much that is laid down on the map can only be taken as very approximate.

AFRICA.

Africa. **Intelligence Division, War Office.**

Africa. Scale 1 : 1,000,000 or 15·8 stat. miles to an inch (Provisional issue without hills). Sheets: 3, North-West Morocco; 10, South-West Morocco. London: Intelligence Division, War Office; Stanford. *Price 2s. each sheet. Presented by the Director of Operations, Intelligence Department.*

German East Africa. **Sprigade and Moisel.**

Karte von Deutsch Ostafrika. Begonnen unter Leitung von Dr. Richard Kiepert, fortgesetzt unter Leitung von Paul Sprigade und Max Moisel. Scale 1 : 300,000 or 4·7 stat. miles to an inch. Sheet G 5 and H 5. Mittlerer Rowuma. Berlin: D. Reimer (Ernst Vohsen). *Presented by Herr Paul Sprigade.*

Sahara. **Nieger and Renaud.**

Carte des Oasis Sahariennes. Scale 1 : 250,000 or 3·9 stat. miles to an inch. Publiée sous les auspices de la Société de Géographie de Paris. Dressée et dessinée par le Lieutenant Nieger des Tirailleurs sahariens et le Maréchal des Logis Renaud des Spahis sahariens. 9 sheets. Paris: Henry Barrère, 1904.

This map will be specially noticed in the *Geographical Journal.*

South Africa. **Wood and Ortlepp.**

Standard map of South Africa, specially compiled by J. T. Wood, M.A., and A. A. Ortlepp. Scale 1 : 1,267,200 or 20 stat. miles to an inch. 4 sheets. Cape Town: The "Cape Times, Limited," 1904. *Price £3 3s. Presented by the Publishers.*

This is a large general map of the whole of South Africa south of the Zambezi,

containing a considerable amount of detailed information. It is based upon the so-called "Briton or Boer" map which appeared during the war, with many additions from the best sources. The map is printed in five colours on four sheets, and when these are mounted as one measures 7 × 5½ feet. It can be obtained on rollers, varnished, or in two sections, folded in case, for £4 4*s*. Each section, north or south, can be obtained separately for £2 2*s*.

AMERICA.

Alaska. **Department of the Interior.**

South-Eastern Alaska and part of British Columbia, showing award of Alaska Boundary Tribunal, October 20, 1903. Scale 1 : 900,000 or 14·2 stat. miles to an inch. Ottawa: Department of the Interior. *Presented by the Department of the Interior, Canada.*

The boundary is shown by a red broken line connecting the points, designated by letters, and referred to in the Award of the Tribunal. The topography is from the Canadian Boundary Commission Photo-topographic Surveys of 1893–1895, undertaken especially in connection with the boundary question.

Bolivia. **Germann.**

Mapa de la República de Bolivia levantado y construido sobre suo propios estudios durante diez años y las mejores fuentes existentes por el Injeniero Franz Germann. Scale 1 : 2,000,000 or 31·5 stat. miles to an inch. 4 sheets. Hamburg: L. Friederichsen & Co., 1904. *Presented by the Publisher.*

In addition to the usual hill-shading, an attempt has been made on this map to represent the relief by a system of contour-lines at intervals of 500 metres; but in the absence of exact survey work these lines can only be considered as the roughest approximation. This map has been prepared from the author's own surveys and explorations, combined with the work of other travellers, and a list is given of the authorities consulted. It differs in many respects from Gen. Pando's map, which appeared recently, and others, and it certainly might have been more complete had greater care been taken to make good use of the best available material.

Brazil and Bolivia. **Brazilian Government.**

Mappa mostrando a nova fronteira entre o Brasil e a Bolivia. Scale 1 : 1,500,000 or 23·6 miles to an inch. 2 sheets. Região Amazonica; Região Austral de Matto Grosso. Rio de Janeiro: Gabinete de Ministro das Relações Exteriores. *Presented by the Brazilian Minister for Foreign Affairs.*

This map shows the frontier between Brazil and Bolivia according to the treaty of 1867, and the modifications of the frontier according to the treaty of 1903. It also shows, by colour-tinting, the territory transferred by Bolivia to Brazil by the latter treaty, to the north and south of the parallel of latitude 10° 20′ S., and that ceded by Brazil to Bolivia. A green line indicates the boundary claimed by Peru. The map has been utilized in the compilation of that illustrating Colonel Church's paper which appears in the present number of the *Geographical Journal.*

Canada. **Department of the Interior.**

Map of the North-West Territories and the Province of Manitoba. Scale 1 : 792,000 or 12·5 stat. miles to an inch. 3 sheets. Ottawa: Department of the Interior, 1903. *Presented by the Department of the Interior, Canada.*

Canada. **Surveyor-General's Office, Ottawa.**

Sectional map of Canada. Scale 1 : 190,080 or 3 stat. miles to an inch. Portage La Prairie Sheet (10), West of Principal Meridian, revised to November 16, 1903; Fairford Sheet (12), West of Principal Meridian, revised to February 29, 1904; Brandon Sheet (18), West of Principal Meridian, revised to February 10, 1904; Riding Mountain Sheet (19), West of Principal Meridian, revised to February 29, 1904; Shell River Sheet (55), West of Third Meridian, revised to February 13, 1904; Bad Hills Sheet (60), West of Third Meridian, revised to August 18, 1903. Ottawa: Surveyor-General's Office. 1903. *Presented by the Surveyor-General of Canada.*

N.B.—It would greatly add to the value of the collection of Photographs which has been established in the Map Room, if all the Fellows of the Society who have taken photographs during their travels, would forward copies of them to the Map Curator, by whom they will be acknowledged. Should the donor have purchased the photographs, it will be useful for reference if the name of the photographer and his address are given.

List of Positions fixed Astronomically and by Triangulation,

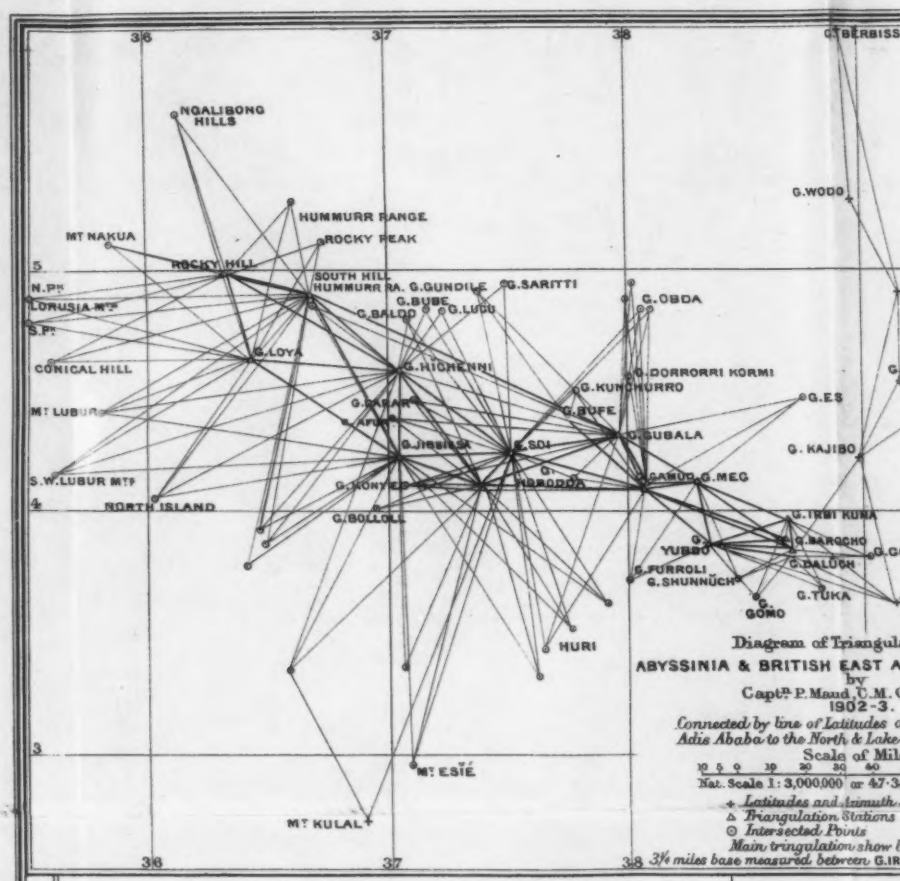
BY

CAPTAIN P. MAUD, C.M.G., R.E.

ABBREVIATIONS.

+ Latitude and Azimuth. △ Triangulation Station.
⊙ Triangulation Intersected Point. H.P.—Highest Point.

Place.	Latitude North.	Longitude East.	Fixed by.	Height in Feet	Remarks.
	° ′ ″	° ′ ″			
British Residency, Adis Ababa.. ...	9 1 42	38 45 35		8036	Grass plot on East of Residency. Lat. observed. Long. calculated from Swayne's.
G. Zukwala	8 31 51	38 49 52	+	10123	H.P. Trees S. of crater.
Camp Dubisa.. ...	8 8 57	38 47 51	+	5582	On right bank Mukki R.
Camp Wurranto ...	8 1 58	38 42 37	+		On west shore of L. Zwai. H.P. of open rise of ground.
G. Alutu...	7 46 1	38 43 27·9	+	7773	N.W. peak not H.P.
G. Alacha	7 6 42	38 32 42·3	+	7060	H.P. N. of dead tree on edge of precipice.
Sisha Village... ...	6 40 7	38 28 48.1	+	8075	H.P. high thin cotton tree within stockade.
G. Maskulli	6 32 47	38 29 15·6	+	9055	High Giant Cactus tree E. of cactus tree on H.P.
G. Hŏnko	6 28 23	38 32 29·6	+	9289	On E. side of hill. Difficult point to recognise.
G. Suta	6 19 47	38 35 59·8	+	9373	H.P. cairn.
Boko Village or Irba Moda	6 14 47	38 41 45·5	+	8774	S.W. corner of stockaded village.
G. Bĕrbissa Tuto...	5 59 50·5	38 54 25·2	+	7718	H.P. of bare rocky knoll W. of forest clad H.P.
Camp Darar	5 35 27·7			5492	W. of road, right bank of nullah.
Camp: South bend of Canale River...	5 29 41·3				Near mouth of L. Uchunnuche.
Wodo Peak	5 17 11·9	38 57 40·6	+	5452	H.P. most prominent grassy peak. Cairn.
G. Derre Dima ...	4 53 55	39 10 9·8	+	3338	H.P.
G. Illadu	4 39 21·4	39 21 43·3	+		Highest accessible point centre of hill N. of prominent inaccessible rock, which is H.P.
G. Okoto	4 29 48·9	39 24 20·8	+	3537	H.P. flat rock.
Camp Mittita ...	4 30 32			4286	Near pond on high ground.
G. Dodo	4 12 58	39 42 15·5	+	3583	H.P.
G. Gŭrbi...	4 31 54·2	39 10 10·9	+	4082	H.P. S.W.
G. Kajibo	4 13 5 3	38 58 44	+	5001	H.P. flat rock. Cairn.
G. Jima	3 58 56·9	39 27 6·1	+	5054	H.P. N. of flat top. Difficult to recognise.
El Chillako	4 10 31			3127	Well.
Camp Murri	4 16 32				On stony plateau overlooking dom palm grove, near road.
Banissa	3 56 44			3298	Centre of open space containing wells.
G. Bor	3 29 37·5			4690	H.P.
G. Agal	3 36 59·5	39 7 29·6	+ ⊙	5058	H.P. Cairn.
G. Tuka...	3 40 50	38 49 12	⊙	5081	H.P.
G. Daluch	3 49 13·7	38 41 33	+ △	5326	H.P. Cairn. First triangulation station.
G. Irbi Kuna ...	3 57 58·8	38 40 6·9	△	5183	H.P. flat rock. Cairn.
G. Yubdo	3 51 46	38 20 51·9	△	6427	H.P. rocky Peak.
G. Gomo	3 38 49	38 31 59	⊙	5035	Highest tree.
G. Shunnŭch... ...	3 43 7	38 27 28	⊙	5351	H.P. prominent rocky peak.
G. Gof	3 48 25·68	39 1 45·95	⊙	5367	H.P.
G. Furroli	3 42 56·5	38 0 2·9	⊙	6544	H.P. rocky peak.
G. Meg	4 6 47·8	38 17 34·4	△	7567	H.P. flat grassy summit. Cairn.
Gamŭd Peak... ...	4 4 32·6	38 5 19·2	△	8265	H.P. of the southern of two rocky peaks S. of H.P. of G. Gamud stands out prominently viewed from E. or W.
Auxiliary station on G. Gamŭd... ...	4 5 46·6	38 4 49·9	△	8455	Flat rock on extreme edge of western precipice N. of flat summit of G. Gamud. Just N. of some high bush. Difficult to recognise.
G. Es	4 27 55·5	38 43 53·8	⊙	5367	H.P.
G. Gubala	4 18 36·2	37 58 9·3		7729	H.P. of southern and highest of three peaks



Map of part of EAST AFRICA

showing the explorations of

Mr. A.F. BUTTER'S EXPEDITION

From a survey by

CAPTN. P. MAUD, C.M.G., R.E.

1902 - 3.

Scale of Miles.

10 5 0 50 100

Nat. Scale 1: 2,000,000 or 31·56 miles = 1 inch.

Route ——

Heights in feet.

G. Gara = Mountain.

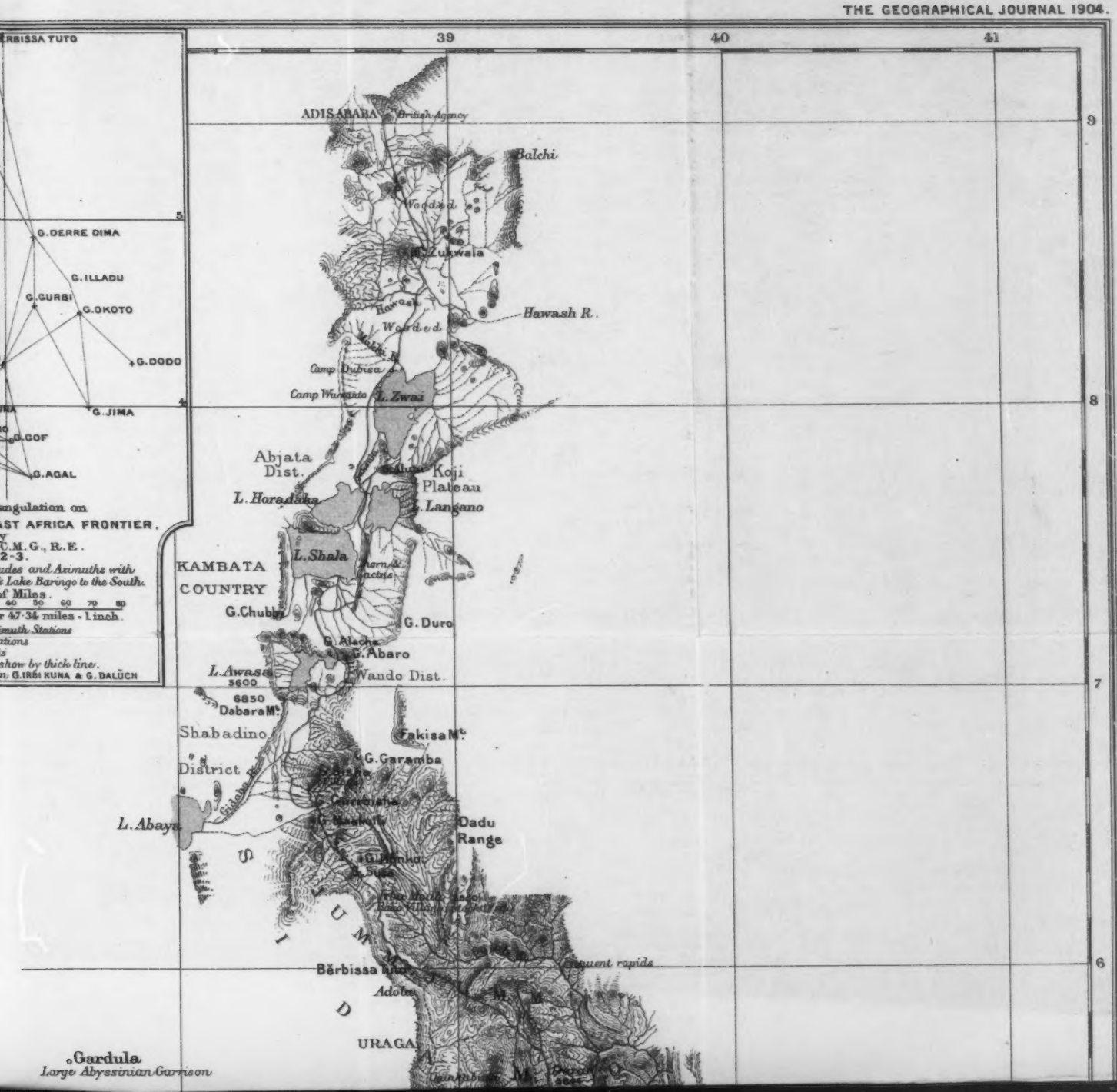
El = Well

Guba = Highland

NGALIBONG HILLS

EAST AFRICA
MAUD.

THE GEOGRAPHICAL JOURNAL 1904.



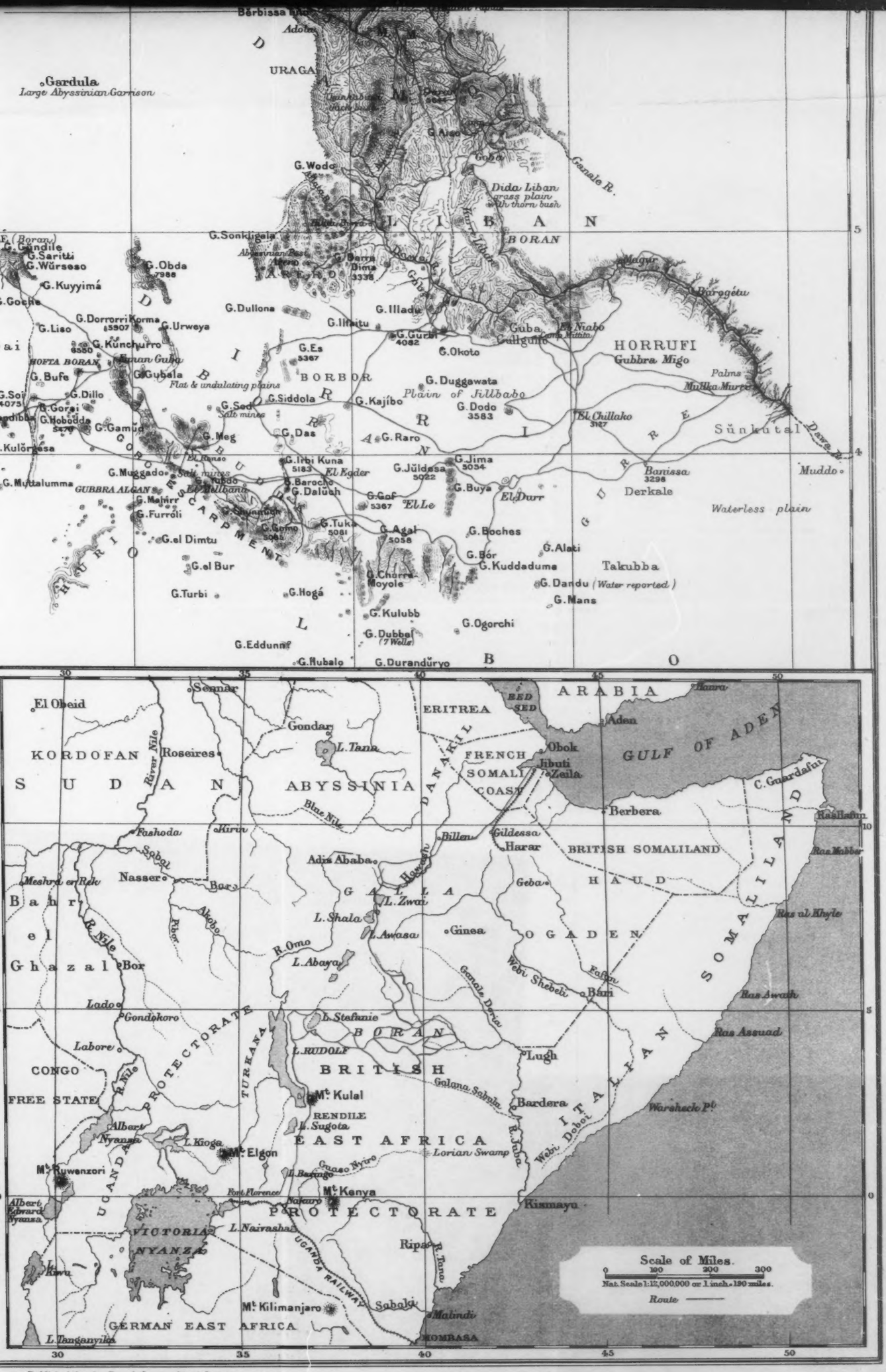
viewed from E. or W.

Auxiliary station on G. Gamŭd	4	5	46·6	38	4	49·9	△	8455 Flat rock on extreme edge of western precipice N. of flat summit of G. Gamud. Just N. of some high bush. Difficult to recognise.
G. Es	4	27	55·5	38	43	53·8	⊙	5367 H.P.
G. Gubala	4	18	36·2	37	58	9·3		7729 H.P. of southern and highest of three peaks nearly same height.
G. Hobodda	4	7	40·3	37	46	29·1	⊙	5478 H.P.
G. Dorrorri Korma	4	34	2	38	0	31·5	⊙	5907 H.P.
G. Obda...	4	48	51·3	38	5	31·5	⊙	7988 H.P. of range.
G. Obda...	4	49	37·1	38	3	52·3	△	H.P. peak N.W. of H.P. of range.
G. Obda...	4	56	36·2	38	1	48·9	⊙	H.P. sharp peak N. end of range. The eastern of two peaks about same height.
G. Obda...	4	52	2·9	38	0	8·8	⊙	H.P. low pointed peak W. end of range.
G. Kunchurro ...	4	29	41·7	37	47	19·5	⊙	6550 H.P.
G. Bufe	4	21	51·7	37	45	17·9	△	4695 H.P. south end of flat summit. Cairn.
G. Soi	4	14	42·7	37	31	26·1	△	4075 H.P. Cairn.
G. Dibbandibba ...	4	6	46·7	37	24	12·8	△	3770 H.P. on edge of crater. Cairn.
G. Saritti	4	55	35·9	37	30	5·4	⊙	H.P. of
G. Gŭdile	4	53	45·8	37	25	29·4	⊙	6774 H.P.
G. Baldo	4	47	16·7	37	5	44·8	⊙	H.P.
G. Bube	4	49	11·6	37	10	40	⊙	6218 H.P.
G. Lugu	4	49	7·2	37	14	49·8	⊙	H.P.
G. Hichenni	4	34	53·4	37	3	29·8	△	7342 H.P. small grassy knoll.
G. Darar...	4	27	15	37	6	50	⊙	6714 Tree. H.P. rocky peak seen only from eastern side of range.
G. Afur	4	22	15·6	37	2	2	⊙	6319 H.P. rounded grassy knoll.
G. Jibbissa	4	13	19·1	37	2	57·9	△	5563 H.P. of the most easterly of the three high peaks of this hill. Cairn.
G. Konye	4	6	2·4	37	4	54	⊙	H.P. sharp rocky peak
G. Bolloll	4	0	12·6	36	56	37·8	⊙	H.P.
Hill S.E. of G. Furróli...	3	37	27·5	37	54	49·2	⊙	H.P. small hill difficult to recognise
Hill, Huri Dist. ...	3	31	11·9	37	45	45·2	⊙	5154 H.P. small rise on W. side of prominent flat-topped hill.
Hill, Huri Dist. ...	3	26	9·9	37	39	13·8	⊙	5100 H.P. prominent hill in centre of Huri District.
Hill, Huri Dist. ...	3	19	0·6	37	37	53	⊙	5000 H.P. prominent peak extreme S.W. of Huri District.
Mt. Esĭé...	2	57	45	37	5	27·7	⊙	H.P. isolated hill, pointed summit.
Landslip Hill... ...	3	21	29·8	37	4	11·5	⊙	H.P. isolated hill with large landslip on N. side.
Isolated Peak ...	3	20	49·5	36	35	3·7	⊙	3470 H.P.
Three prominent hills S.E. of North Island of Lake Rudolf.	3	46	12·9	36	25	17·9	⊙	H.P.
	3	52	1	36	29	55·7	⊙	H.P.
	3	55	8·6	36	27	42·8	⊙	H.P.
N. Island in L. Rudolf	4	3	25·9	36	2	15·9	⊙	2100 H.P.
S.W. Lubur Mts. ...	4	9	33·1	35	36	53·1	⊙	5050 H.P. N. end of range.
Mt. Lubur	4	24	30·2	35	47	52·1	⊙	5200 H.P. of range-Peak on flat top N. Lubur Mts.
Loya Hill	4	37	14·1	36	26	36·9	△	2989 Big thorn bush, N. end of small detached flat-topped hill, N. of prominent ridge.
Conical hill	4	37	22·7	35	35	14·4	⊙	4370 H.P. N.W. of Mt. Lubur.
S. Peak Lorusia Mts.	4	46	49·1	35	29	46	⊙	6143 H.P.
N. Peak Lorusia Mts.	4	53	10·3	35	30	31·8	⊙	5990 H.P. Tree.
Rocky hill	4	58	30·5	36	21	2	△	3524 Rock, H.P. of highest this detached group of hills.
Mt. Nakua	5	5	44·51	35	52	23·8	⊙	3275 H.P.
Range N.W. Hummurr Range	5	16	37·4	36	37	2·6	⊙	5991 H.P. centre flat top.
Ngalibong Hills ...	5	38	24	36	8	16·3	⊙	5763 H.P. centre of rounded summit, N.E. end of range.
Rocky Peak Hummurr Range ...	5	7	17·3	36	43	43·9	⊙	7022 H.P. prominent rocky peak W. of probable H.P. of range.
S. Hill Hummurr Range...	4	53	25·9	36	41	37·2	△	5930 H.P. centre of flat summit due E. of most southerly tree on summit.
S. Hill, Hummurr Range, South Peak	4	52	56·4	36	41	23·7	⊙	H.P. sharp wooded knoll on S. slopes of S. hill Hummur Range. A good point from E. or W only.
Mt. Kulal	2	43	40	36	54	56·1	+	7812 H.P. centre small open space in centre of thickly wooded summit.
Mt. Indunumara ...	2	12	17	36	54	58·5	+	5574 H.P. knoll on spur W.N.W. of H.P. of Mt. Indunumara.
Mt. Suddim	1	52	51·5	36	52	37·8	+	6157 H P. rocky summit.
Eland Range... ...	1	13	15·4	36	29	25·5	⊙	8715 H.P. wooded summit. Intersected from small measured base. The Lat. and Az. station on watershed of this range not recognisable.
Bare hill S. of Eland Range...	1	0	32	36	31	22·7	⊙	8221 Intersected from small measured base. H.P. tree N. end of flat summit.
Eland Range... ...	1	13	28·2	36	35	11·9	+	8512 Biggest tree on S. end of long grassy spur S. of watershed Eland Range.
Hill S. of Impala Valley...	0	51	10·2	36	25	53·3	+	6467 H.P. N.W. end of flat-topped hill.
Hill east of L. Baringo	0	37	5·9	36	9	55·2	+	4824 H.P. eastern summit

Strong local magnetic attraction on nearly all hills, causing variation from 3° E. to 10° W.

Average normal magnetic variation, 4½° W.

Projection, Secant Conical.



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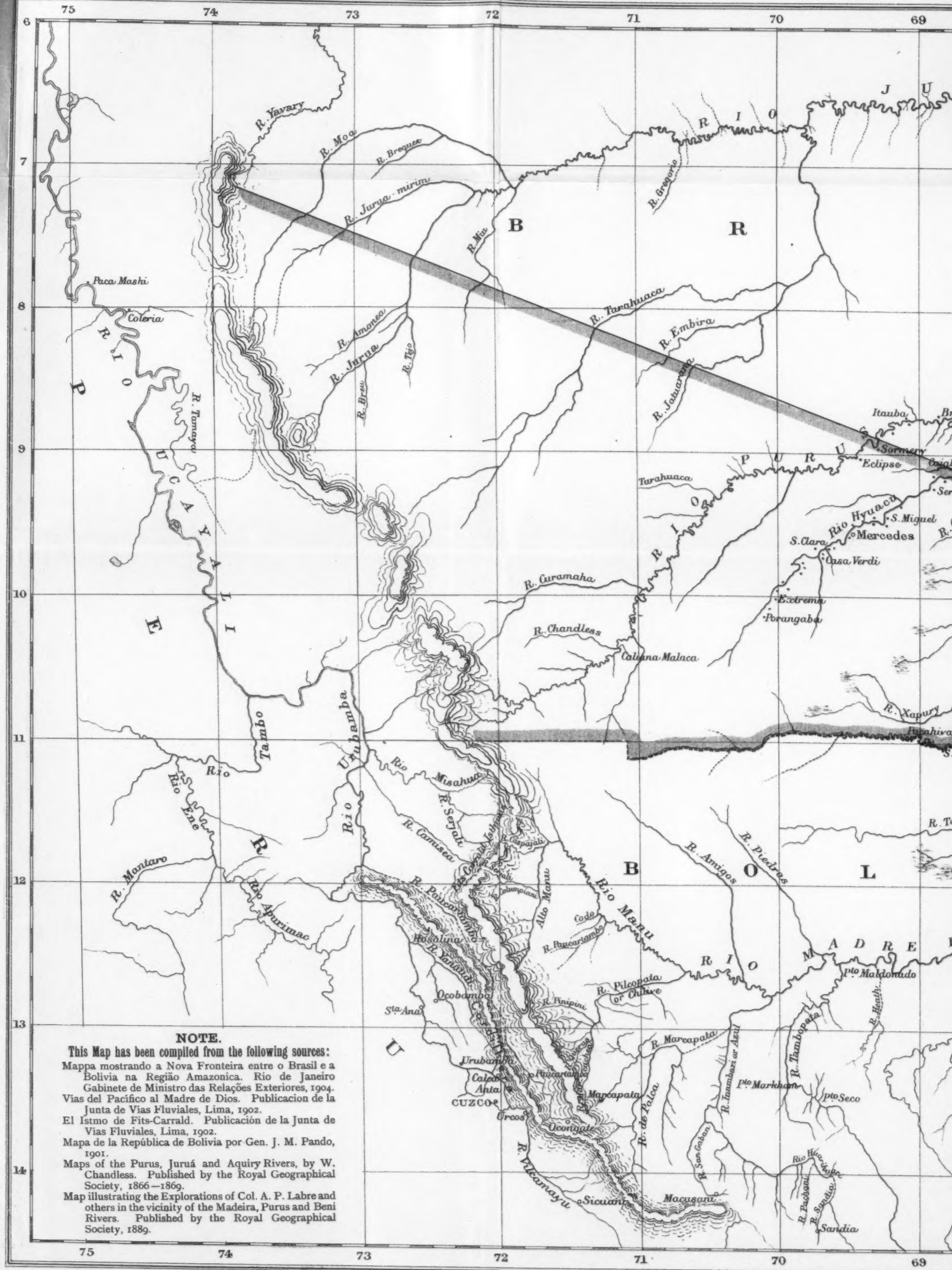


NOTE.

This Map has been compiled from the following sources:

Mappa mostrando a Nova Fronteira entre o Brasil e a Bolivia na Região Amazonica. Rio de Janeiro Gabinete de Ministro das Relações Exteriores, 1904.

Vias del Pacifico al Madre de Dios. Publicacion de la Junta de Vias Fluviales, Lima, 1902.

El Istmo de Fits-Carrald. Publicación de la Junta de Vias Fluviales, Lima, 1902.

Mapa de la República de Bolivia por Gen. J. M. Pando, 1901.

Maps of the Purus, Juruá and Aquiry Rivers, by W. Chandless. Published by the Royal Geographical Society, 1866—1869.

Map illustrating the Explorations of Col. A. P. Labre and others in the vicinity of the Madeira, Purus and Beni Rivers. Published by the Royal Geographical Society, 1889.

Secant Conical Projection

Published by the Royal Geographica

THE ACRE TERRITORY
AND THE
CAOUTCHOUC REGION
OF
SOUTH-WESTERN AMAZONIA

Showing Frontiers according to the
Treaty of 1903.
between Brazil and Bolivia.

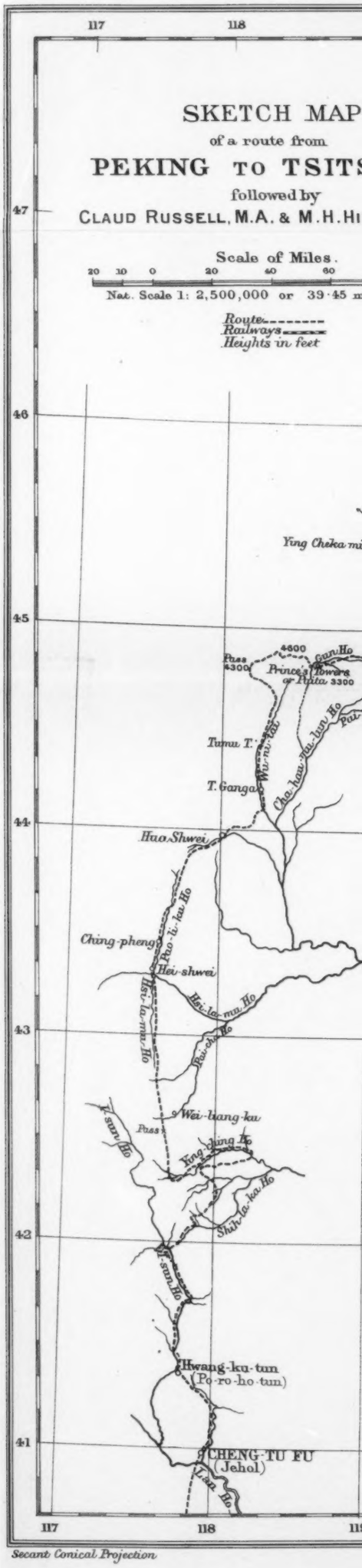
Scale of Miles.

10 5 0 10 20 30 40 50 100

Nat. Scale 1:3,000,000 or 47·3 miles = 1 inch

Reference.

Frontier according to the Treaty of 1867.
Modification of the Frontier by Treaty of 1903.
Territory transferred by Bolivia to Brazil
" " " Brazil to Bolivia



Secant Conical Projection

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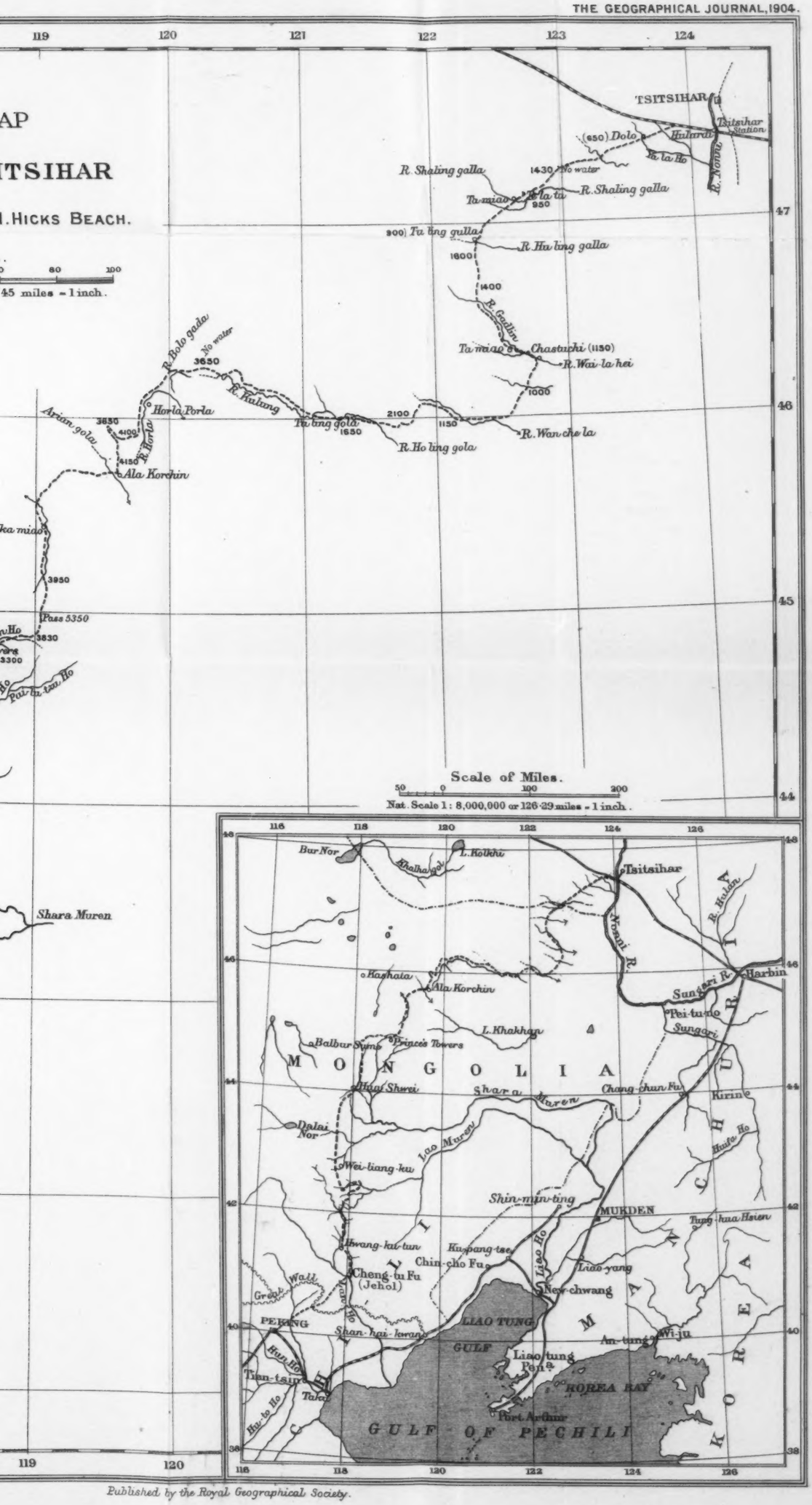
L. HICKS BEACH.

45 miles = 1 inch.



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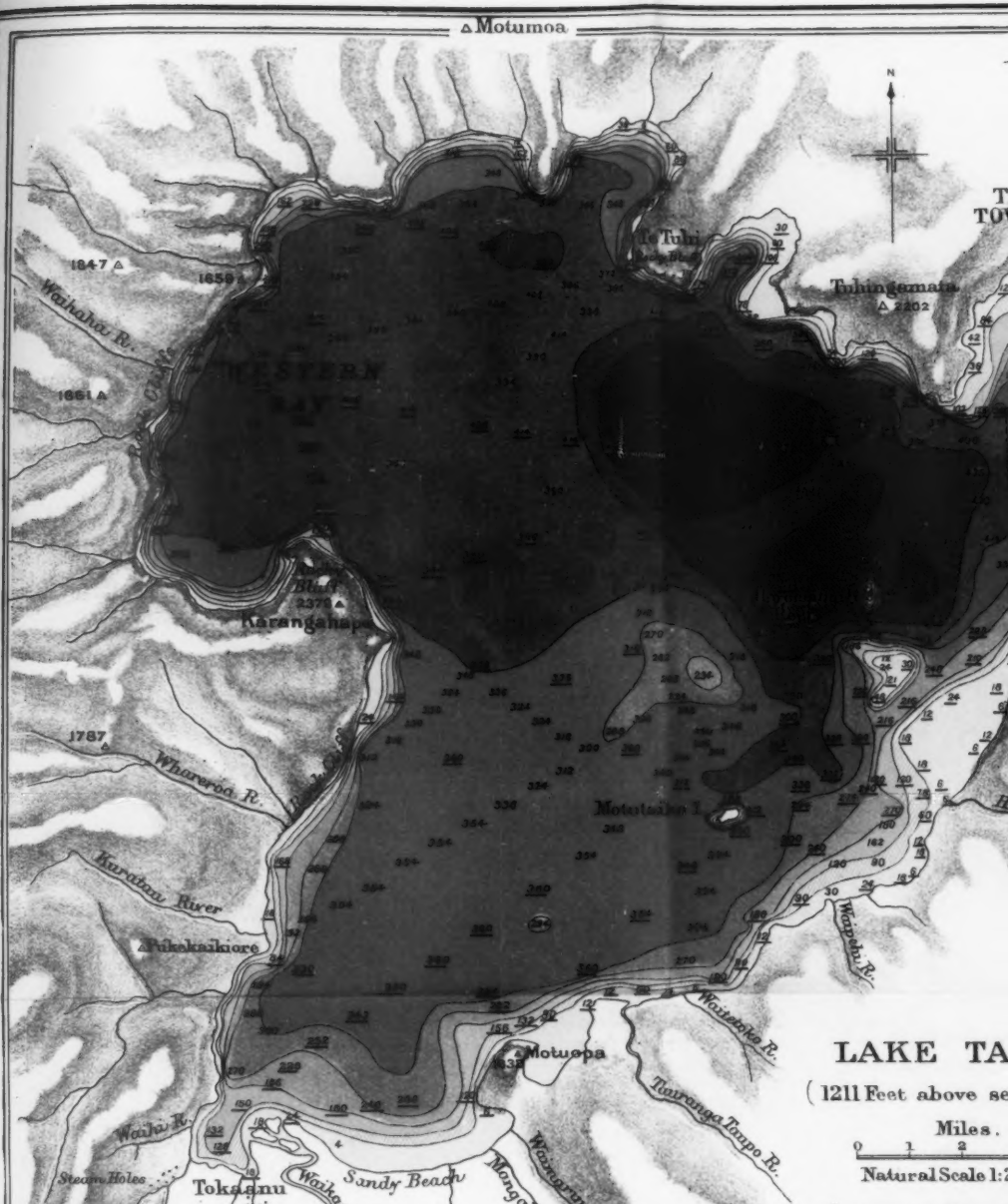
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Karangahape
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1787
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Motutaiko I.
Kuratau River
Pukekaikiore
Waipehi R.
Waitetoko R.
Motuapa
1638
Tauranga Taupo R.
Waihi R.
Steam Holes
Tokaanu
Waikato R.
Sandy Beach
Waiorongomai R.
Mangakowhai R.
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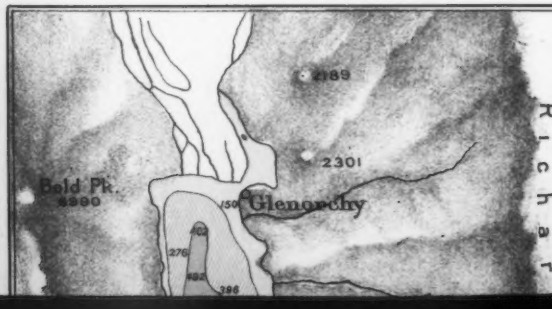
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THE NEW ZEALAND LA

from Surveys by

KEITH LUCAS, B.A.

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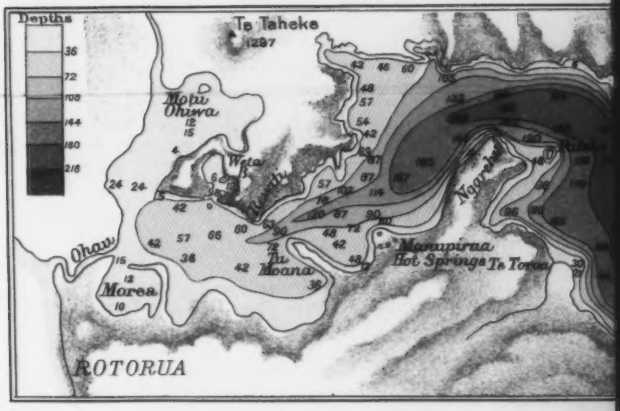

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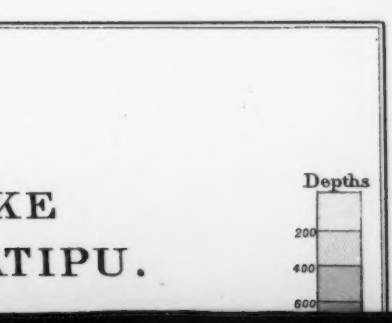
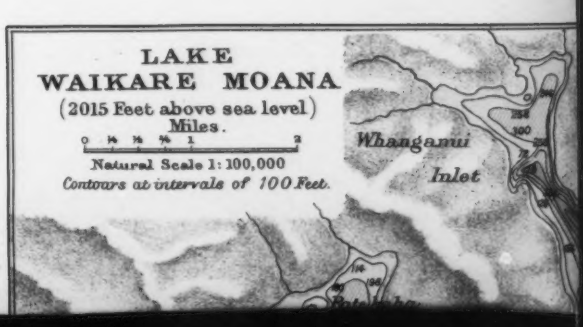
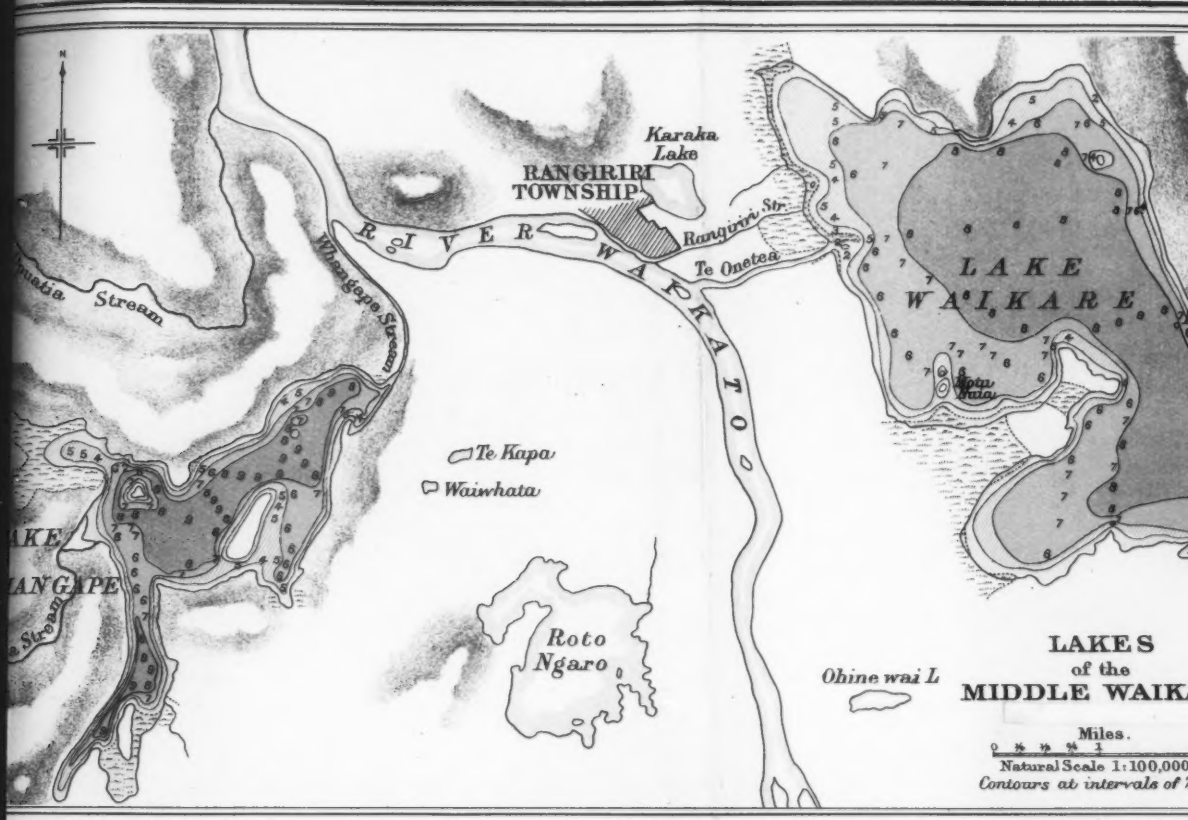


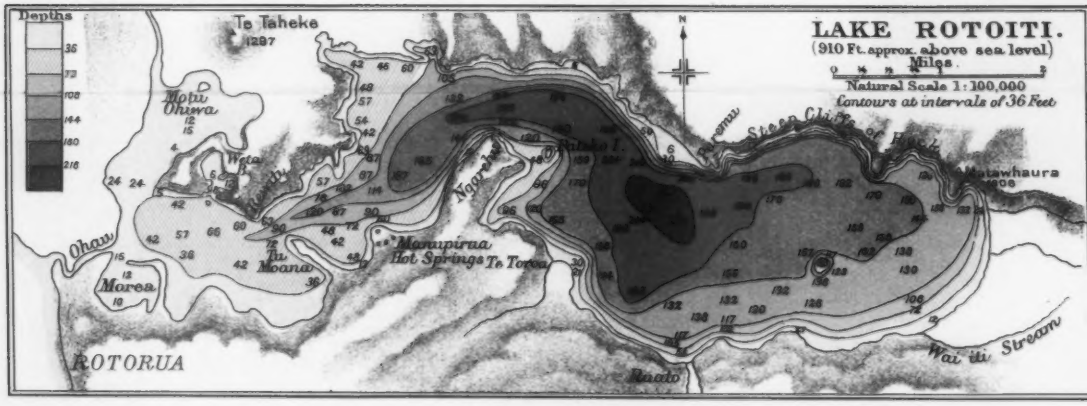


E NEW ZEALAND LAKES

from Surveys by

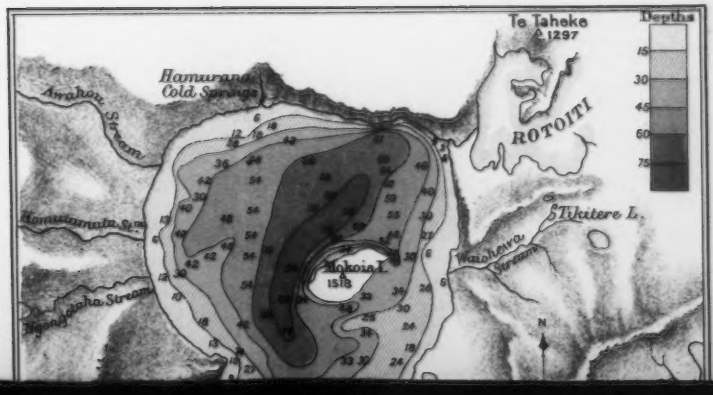
KEITH LUCAS, B.A.



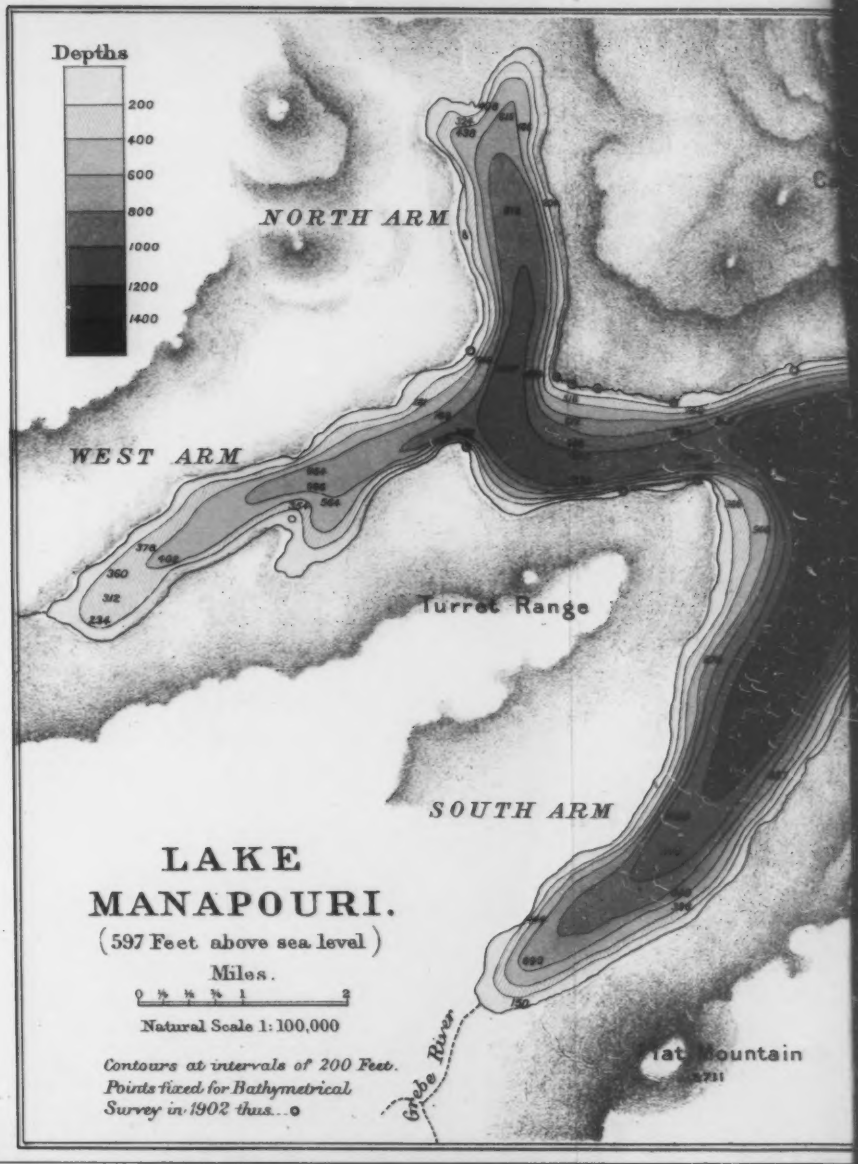


NEW ZEALAND LAKES.

LUCAS.



N.B. The hill shading surrounding the lakes must only be considered approximate



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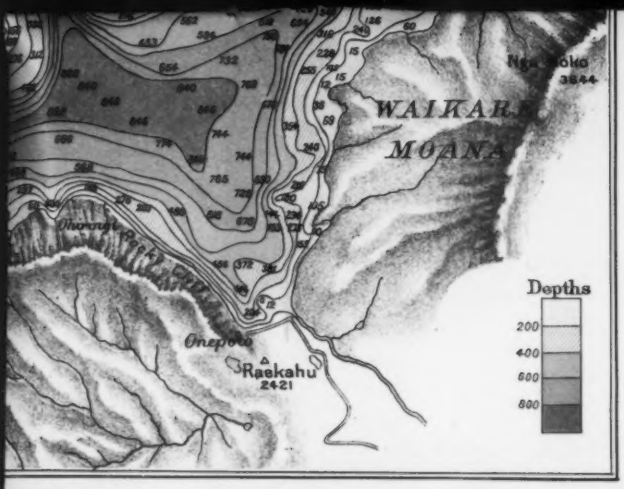
WAIKARE
MOANA
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Raekahu
2421

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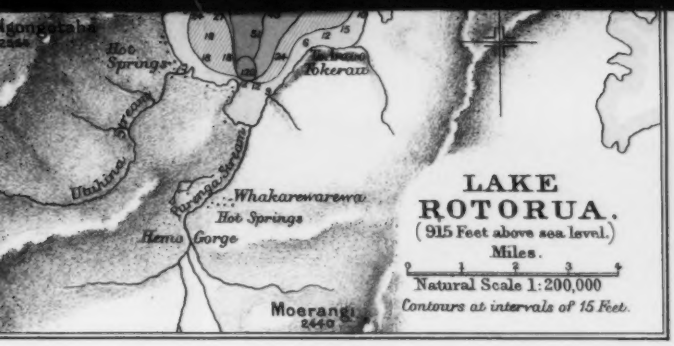
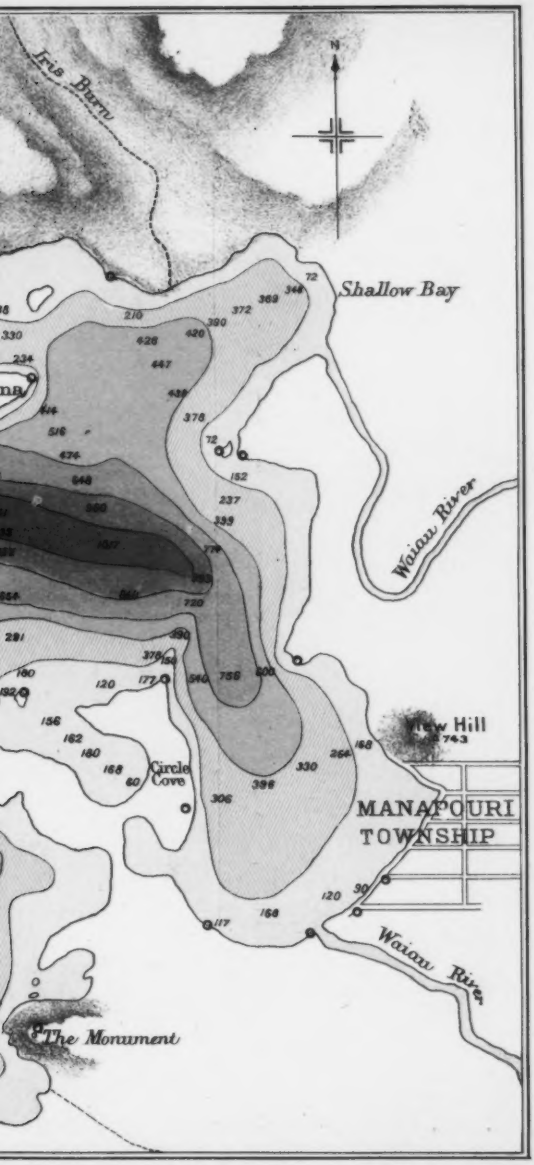
Calm Bay
The Beehive
Rona I.
Pomona I.
Cone Peak
4875
Hope Bay





Heights and Depths in feet.